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AN EVALUATION SYSTEM FOR FOODSERVICE EQUIPMENT

BY

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This report should be used as a tool to evaluate the possibility of procuring foodservice equipment. It lists factors that may be used to select the optimal piece of foodservice equipment for a given purpose. A system of equipment evaluations for specific machines has been developed from these general parameters. Each piece of equipment has an evaluation form which will provide a method to compare items. It has a numerical ranking system which converts the information to a quantitative comparison basis. The selection of a specific machine has been broken into three main categories: operation of machine, cleaning and maintenance, and service and reliability. The following is a list of factors requiring consideration when evaluating foodservice equipment: (1) capacity, (2) consistency of operation, (3) ease of operation, (4) safety and compliance to health codes, (5) frequency of cleaning and maintenance, (6) amount of cleaning and maintenance, (7) ease of cleaning and maintenance, (8) durability and reliability, (9) energy efficiency, (10) warranty, and (11) service. Each form has a guide which provides background information and criteria for completion of the form.

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Keywords: Operational effectiveness.

Preface

This report was completed by means of an IPA Assignment Agreement between Cornell University and the U.S. Army Natick Research, Development and Engineering Center (NRDEC), under Program Element No. 728012.19. The project officer for NRDEC is Mr. Leo J. Harlow.

This Center agreed to hire Dr. John B. Knight to investigate and identify parameters for evaluation of foodservice equipment. Not only will this Center have a useful tool to help assess foodservice equipment, but the University will also benefit from the practical experience gained by Dr. Knight, which will enhance both his teaching and research assignments.

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INTRODUCTION

Purpose of Study

To provide the Systems Engineering Division of the Food Engineering Laboratory at U.S. Army Natick Research and Development Center (recently renamed the U.S. Army Natick Research, Development and Engineering Center) with the technical capability necessary to accomplish the complex analyses associated with military field foodservice programs, a test protocol was developed for evaluating selected items of commercial foodservice equipment for military use.

Foodservice equipment purchases are a significant expense for foodservice operators. In the early 1980s, foodservice equipment purchases totalled over three billion dollars.[1] Moreover, a survey showed that 70 percent of operators interviewed were planning to purchase a major item of foodservice equipment during the next twelve months.[2] Because selection of the optimal piece of equipment is of major importance to foodservice operators for the military as well as for industry, this study was undertaken to identify and weigh all aspects pertinent to making a selection.

Procedure

Selection of a specific machine requires consideration of many factors. These factors fall into three main categories: operation of machine, cleaning

and maintenance, and service and reliability. Each category has several subcategories.

The protocol is intended to permit equipment to be evaluated for functional design, implementation, and performance, in particular -- capacity; quality of product; ease of operation; safety and compliance to health codes; frequency, amount, and ease of cleaning and maintenance; durability and reliability; energy efficiency; warranty; and service. Method of investigation was by visual examination of equipment and its specifications, review of service and operator manuals, personal interviews with commercial and military foodservice personnel, and literature searches on related subject.

To aid the user and prospective purchaser in evaluating equipment, a form was devised that, when completed for each piece of equipment considered, will contain all pertinent information to arrive at a judgmental decision.

In the discussion following, the information given describes general features important in the selection of all types of foodservice machinery. Each feature is defined, and an explanation of its importance to the selection process is included. A series of evaluation systems -- one for each major item of foodservice equipment -- follows in Appendix A.

Prior to the development of this protocol, no accepted or standardized procedures for the evaluation of commercial foodservice equipment existed within the military. It is anticipated that, through the use of this protocol, military foodservice operators are provided with a basis by which they can evaluate the functionality of both current and forecasted commercial processing technologies against military field foodservice requirements and objectives. An additional benefit derived from these analyses will be to economically reduce the volume of selected items.

GENERAL PARAMETERS OF FOODSERVICE EQUIPMENT

Operation of Machine

Capacity.

Capacity of a machine may be defined as the maximum rate it can accomplish the task for which it was designed. Practical definitions applied to foodservice equipment require further specificity. Maximum capacity is the absolute greatest rate the machine can perform its function. Maximum working capacity is the highest rate a machine can consistently perform its function. Minimum working capacity is the slowest effective rate a machine can work, either from an economic or physical parameter. Also to be considered in studies of capacity is the rate of maximum efficiency, or the rate of operation that produces a product of the highest quality at the least expense per portion.

It can easily be seen that these aspects are important when evaluating and selecting foodservice equipment. A piece of equipment ideally should be selected so it consistently works at or near its rate of maximum capacity, it never falls below its minimum working capacity, and it is never expected to exceed its absolute maximum capacity. These relationships are shown in Fig. 1.

Operation of any machine below its minimum or above its maximum physical capacity is not possible; no product will be produced. In between the minimum and maximum end points, the quality of product produced and the efficiency of the machine's operation will increase to a certain point and then decline as the maximum machine capacity is approached. The goal of the manufacturer

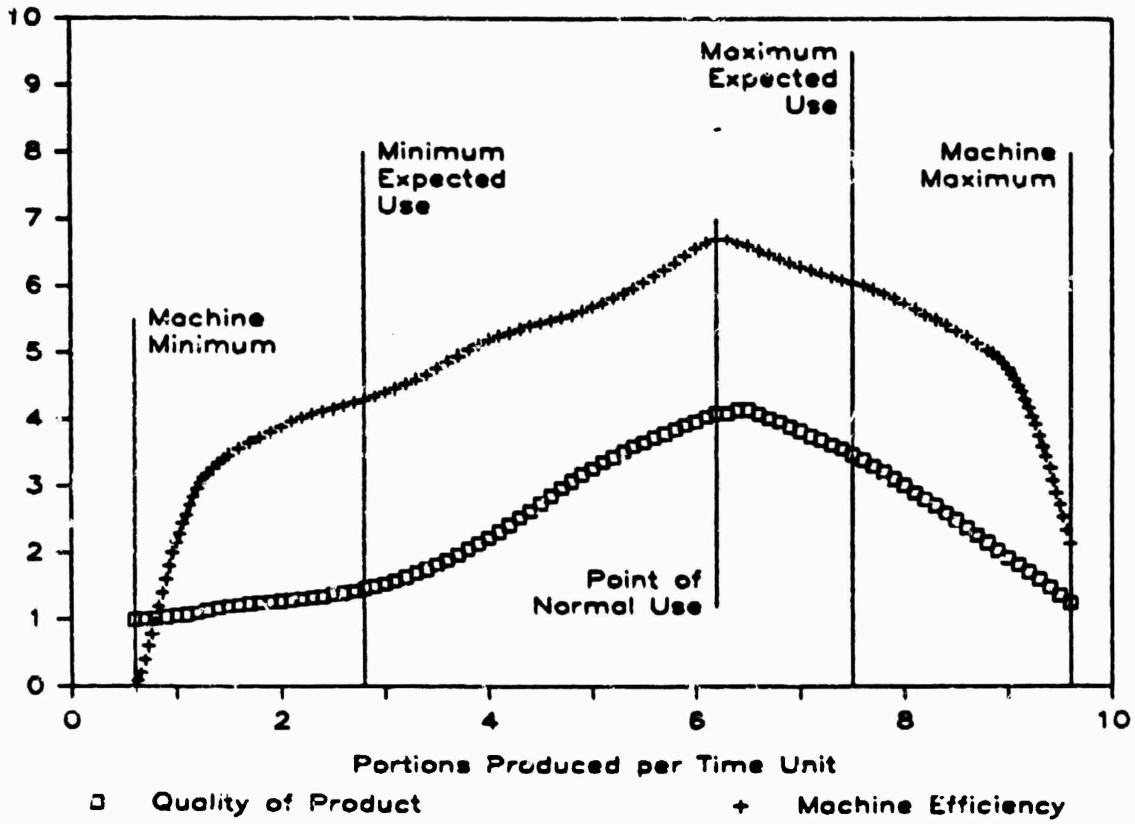

Figure 1. Ideal utilization of machine capacity.

should be to produce a machine with peak machine efficiency at the same production rate that produces the highest quality product. As projected in Fig. 1, this point is at 6.2 portions per time unit. A purchaser of a machine should select a machine so that the point of normal use, or rate at which it is expected to operate the machine most frequently, is at or near the peak performance of the machine -- again, in this example at 6.2 portions per time unit. The operator must also ensure that the minimum and maximum expected use rates fall within the end points of the machine's physical capacity.

Two aspects of capacity must be considered when selecting equipment: the pattern of individual requirements, and the pattern of a manufacturer's

compliance with practical limitations. For example, ideally, a manufacturer should produce a machine so its rate of maximum efficiency is at its maximum working capacity. The operator should select a machine so its point of maximum efficiency is at the operator's point of normal usage.

Thus, the first step in selecting an individual piece of equipment must be to define the operator's parameters of capacity:

> At what rate will the machine normally be expected to function?
>
> What is the maximum expected rate of performance under unusual circumstances?
>
> What is the slowest rate at which the machine will normally have to operate?

According to the American Gas Association, to calculate the necessary capacity one must --

1. Select a sufficient number of typical menu items, so that all typical foods to be processed through the equipment are listed;

2. Determine anticipated number of portions required and the portion size to be served;

3. Multiply the number of portions by portion size to obtain total quantity required as served;

4. Calculte peak demands, or calculate a maximum number of portions per minute;

5. Calculate normal number of portions per minute;

6. Consider loss of quality of product from excessive holding time, and loss of quality due to too large a batch size;

7. Evaluate alternative cooking methods for efficiency and use of equipment for other processes.[3]

Accuracy of the capacity calculation is critical, as the remainder of the operator's required specifications must be based on the calculated capacity. Using the calculated capacity, the operator needs to develop a complete list of specifications encompassing all the requirements the specific machine must have. Utilizing two smaller machines for the same function to provide insurance in the event of breakdown may be desirable. However, reducing the size of the machine typically increases the labor, as more batches must be run.[4] Factors unique to the operation, such as excessively hard water, no gas, space limitations, etc., should be clearly indicated.

Consistency and Quality of Product

Consistency and quality of product are affected by deviations from ideal conditions of machine use. Under ideal conditions, it may be assumed that a product will be produced that is consistently of good quality. The important considerations are -- what are ideal conditions, and how much deviation from them may occur before product quality and consistency suffer? Does the individual manufacturer define ideal conditions at point of maximum efficiency, or is it some hypothetical situation achievable only under laboratory conditions?

An example of deviation from ideal standards is cool spots in convection ovens. The U.S. Army Natick Research and Development Center ran tests using commercial convection ovens. All ten shelves of the ovens were loaded with four pans per shelf of frozen food product. The fastest pan reached 160°

Celsius in 120 minutes, while the slowest took 180 minutes.[5] This variation is due to overloading of the ovens and design flaws or deviations from ideal conditions.

Comparisons in quality must be objective, and they must compare product prepared in similar ways. A hamburger that is griddled on a flat griddle will cook faster than one that is charbroiled.[6] It will also be very different in taste and appearance than one that is charbroiled. These differences need to be compensated for when evaluating a machine for consistency and quality of product.

Ease of Operation.

What is the probability of neglecting to perform a step in either the setup or operation of a machine? How much does the omission of a given step affect the ultimate performance of the machine?

Arthur Avery suggests that ease of operation has a signigicant effect on reducing employee turnover. For example, if an employee has to stoop over to operate the machine, his fatigue level will increase and he may quit.[7] Controls need to be within comfortable reach and easily operated, handles should be well insulated, and lifting and bending requirements should be minimized.

Obviously, the more steps required to set up and use a machine, the greater the possibility of omitting one or more steps. Thus, one way to measure ease of operation would be to calculate how many steps are involved in the operation of the machine. Another measure of ease of operation is the amount of training

required for proper use of the equipment. If a large amount of training is required, the machine is not as easy to use as one that requires little training.

Closely related to ease of operation is the degree of detectability of an error. If the machine isn't turned on, it is easy to detect. The omission of a manually inserted solids trap in a dishwashing machine may not be detected until the drain becomes plugged.

Safety and Compliance to Health Codes.

Safety must take into account all physical aspects of the machine. All steps of the machine's performance and care must be possible without the operator being placed in significant danger. The machine's construction must be acceptable to any applicable health codes.

Several organizations provide guidelines in this area. ASME (American Society of Mechanical Engineers) governs pressure vessels and pressure lines. UL (Underwriters Laboratory) covers electrical standards, and the AGA (American Gas Association) monitors gas equipment. NSF (National Sanitation Foundation) standards incorporate OSHA (Occupational Safety and Health Act) safety requirements as well as providing minimum standards for materials permissible in construction, where they may be used, methods of fastening, and other limitations that health regulatory agencies may place on construction of foodservice equipment. Basic NSF guidelines for general foodservice equipment are discussed in the "Cleaning and Maintenance" section of this paper.

Liability risk is a stong incentive for manufacturers to produce a safe

machine. Safety may become a more important variance among manufacturers if the Product Liability Act is passed. This act requires the operator to prove negligence on the part of the manufacturer for liability claims. Punitive damages are limited to the first person bringing suit, and if a jury determines the "benefits and usefulness of the product to the public outweigh the likelihood of harm," the manufacturer is not liable.[8]

Cleaning and Maintenance

General.

NSF guidelines provide minimum specifications for items related to cleaning and maintenance. These include internal corners rounded to minimum radii without use of solder; all surfaces smooth and free of crevices, ledges, inside threads and shoulders, bolts, and rivet heads; non-cracking coatings; all construction materials non-toxic, non-absorbent, and chemically non-reactive with food or cleaning agents: all construction materials should impart no significant color, odor, or taste to food; waste should be easily removable.[9] Equipment should have a permanently attached plate describing cleaning procedures.[10] Parts that are difficult to clean should be protected from dirt, and equipment should not promote unsanitary employee practices.[11] NSF defines easily cleanable as: "readily accessible, and of such material and finish and so fabricated that cleaning may be accomplished by normal methods.[12] The majority of the machine's parts should be easily cleanable.

An important consideration when comparing cleanability is that NSF standards are minimums. An individual manufacturer may exceed the NSF guidelines making an appreciable difference in cleanability. For example, NSF specifies a minimum radius of 1/8" for an internal two-corner joint.[13] If this were increased by the manufacturer to 1/4", the machine would be more easily cleaned and maintained.

Frequency of Cleaning and Maintenance.

How often must maintenance other than normal cleaning be performed on the equipment? Are there a large number of daily tasks as opposed to weekly tasks,

or monthly tasks? A daily maintenance task that becomes part of the daily routine is not likely to be forgotten. Is the manufacturer, by specifying only monthly maintenance, stretching to the limit the performance specifications of the part ultimately affecting the durability of the equipment? Some maintenance procedures can cause as much damage if performed too frequently as if not often enough. A purchaser of equipment needs to be able to interpret maintenance specifications for proper frequency of maintenance procedures.

The majority of cleaning tasks needs to be performed at least daily. For those other than daily, the same chance of forgetting the task must be considered as in the maintenance of the machine.

Amount of Cleaning and Maintenance.

Is there so much cleaning and maintenance required that the cost of performing it becomes prohibitive? Total number of tasks required in maintaining and cleaning a machine is a good indicator of the amount of maintenance required. Are the specifications furnished by the manufacturer accurate and realistic? For example, in Appendix B, two daily cleaning procedures for coffee urns are reproduced. In both procedures, directions are complete and easy to follow, but note the significant differences in procedure. Procedure I requires the use of an urn cleaner daily. Procedure II specifies that water be left in the urn overnight. There is a significant time and cost difference between the two procedures. The evaluator needs to be able to recognize these differences.

Ease of Cleaning and Maintenance.

Ease of maintenance and cleaning refers to the amount of time required for each individual task. Required disassembly of the machine for cleaning or maintenance increases the difficulty of those tasks. If tools are required for disassembly, the procedure becomes more complicated. Use of tools and frequent disassembly will lead to wear and increased repair cost on parts specifically involved in the disassembly/reassembly process. If an area of a machine is difficult to reach, there is a greater probability it will not be properly cleaned or maintained.

NSF defines accessible as "capable of being exposed for cleaning with the use of simple tools such as a screwdriver, pliers, or an open-end wrench;" and readily accessible as "exposed, or capable of being exposed for cleaning and inspection without the use of tools."[14] Obviously the more cleaning and maintenance points that are readily accessible, the easier these functions will be able to be completed.

SERVICE AND RELIABILITY

Durability and Reliability.

The ultimate test of the durability of a machine is how often it must be replaced. The U.S. Department of Commerce guidelines for some foodservice equipment are: cooling equipment--20 years, slicers--7 to 10 years, dishwashing machines--15 years.[15] These few examples indicate that the durability of foodservice equipment is typically quite high.

Durability parameters are based entirely on physical construction aspects. These aspects of the machine must be examined individually. Some examples of the type of comparison to be made follow. The fewer moving parts, the more durable and reliable the machine will be. Gauge of metal should be compared between machines. A machine weighing more than a similar size, comparable machine may have heavier construction and be more durable. Quality of metal used in moving parts is important, as the most stress is applied to these areas. A welded joint is superior to a spot-welded, bolted, or riveted joint. Casters and legs must be compared. Stainless steel is preferred to galvanized or coated panels on non-food zones and splash zones, where the option is permitted by the NSF. The physical comparison must be as detailed as possible and cover as many specific points as can be examined.

Durability of most machines is high enough that frequent replacement occurs because of energy and time efficiency consideration. Menu changes may be important in the decision to replace equipment. Changing technology, increasing versatility, and quality of product possible from a machine are also frequent factors in equipment replacement.

Energy Efficiency.

Cost of operation of the machine should be minimized. ASTM (American Society for Testing and Materials) was developing specifications for tests by manufacturers to determine energy efficiency.[16] When available, these figures may be used. Energy-use figures for machines not yet covered by ASTM are generally available from the manufacturer. These figures may have to be converted to comparable units, and they may be taken under ideal conditions not feasible for realistic comparison.

Warranty.

A good warranty is indicative of a company's willingness to stand behind its product. Warranties must be compared for duration and scope of coverage. Items that are not included should also be compared, as these omissions and exclusions can create sugnificant differences between warranties.

The availability and type of warranty service must be considered. A manufacturer may authorize a specific local company for warranty service. Some manufacturers provide their own exclusive warranty service giving the operator no option in selecting a service agency. Others have no authorized agents or factory service, thus allowing the operators to select their own service agency.[17] Because direct warranty service by a manufacturer is not as proximate as local service agencies, it will likely be slower than warranty service by local service companies.

Services.

Two aspects of service must be evaluated: the frequency and difficulty of service required, and the quality of service backup from the manufacturer. The

ASTM has provided uniform specifications for manuals accompanying foodservice equipment. Categories included are: unpacking instructions, installation and start-up manuals, operations, maintenance, troubleshooting, repair and component replacement, special tools, and parts list.[18] If possible these manuals should be compared.

Operators tend to purchase equipment based on past experience with a given manufacturer.[19] These typically are service related considerations, and are good indicators of both frequency and quality of service. Different types of machines require different amounts of service, and they vary in the relative difficulty of service.[17] These attributes are shown in Table 1. These differences need to be considered when basing service evaluations on past experience.

TABLE 1.

Service Differences in Foodservice Equipment

Type of equipment never serviced properly	Percentage Respondents Indicating:	Most breakage	
Dishwasher	18%	Dishwasher	21%
Refrigerator	16	Refrigerator	10
Steamer	13	Ice Machine	9
Oven	12	Oven	5
Stove	11	Steamer	5
Ice Machine	10	Other	10

SOURCE: "You'll Fix it When? A Guide to Reputable Repairs for Food Equipment," Restaurants & Institutions. May 1, 1981, p. 211.

The manufacturer's commitment to service must be evaluated. The number of factory service centers, or service centers with factory authorization is a good figure to use when comparing manufacturers. A company's attitude towards warranty service will also show commitment to service in general.

CONCLUSION

The factors described in this paper relating to foodservice equipment selection may be used to accurately select the optimal piece of equipment for a given purpose. From these general parameters, a system of equipment evaluation for specific machines has been developed. The developed system could be used for any of the machines listed in Appendix C.

RECOMMENDATION

It is recommended that, when contemplating a major purchase of foodservice equipment, military foodservice operators use the protocol set forth in Appendix A of this document and thus consider all aspects necessary to aid in evaluating the functionality of such commercial equipment prior to purchase.

This document reports research undertaken at the
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APPENDIX A. Use of Evaluation System

APPENDIX B. Procedures to Clean Coffee Urns

APPENDIX C. A List of Foodservice Equipment

APPENDIX A. USE OF EVALUATION SYSTEM

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APPENDIX A. USE OF EVALUATION SYSTEM

When selecting a piece of equipment, there are several choices that must be made. These choices are independent of the actual evaluation process and should be completed prior to comparison of machines. The descriptive portion of each specific evaluation outlines these choices and their importance to the selection process.

Evaluation forms have been prepared to provide an effective method of comparing similar pieces of equipment. They provide a method of summarizing many different types of information. A numerical ranking system has been used to convert the information to a quantitative comparison basis. This also allows emphasis to be placed on critical factors, while other areas not quite as important may be de-emphasized. Accompanying each form is a guide to completion of the form. These guides provide background information and criteria for completion of the form. Some terminology and formats used are described in the General Parameters section of the text, so the evaluator should be familiar with that section of this report.

Occasionally, a specific machine will score significantly higher than other machines examined. Capital cost also will be significantly higher. This typically reflects a potential increase in longevity, and the evaluator should consider this possibility.

EVALUATION SYSTEM FOR ICE MAKERS

All ice makers function by removing heat from an evaporator with a compression refrigeration system. Enough heat is removed so water flowing across the evaporator plate freezes onto the evaporator, creating ice. The evaporator is a major variable between ice makers. It can be either a flat plate, a patterned mold to produce specific ice shapes, or a cylinder. Ice is removed from the evaporator in one of two ways. Either heat is applied melting the ice off, or ice is continuously shaved off the cold evaporator plate. There are enough fundamental differences between the two types of ice production that they cannot be directly compared.

In the flake method of ice production, the evaporator is a cylinder. Water flows over the inside wall of the cylinder freezing to the surface of the cylinder. The ice is scraped off with a continuously rotating auger. The auger pushes the ice to the top of the cylinder and into the holding bin.

Harvest method machines cycle. Part one of the cycle is the freezing portion. The compressor runs during this portion of the cycle, and water flows across the evaporator plate, freezing to the plate surface. After a certain period of time, the compressor turns off, and the recirculating pump stops the flow of water across the evaporator. The ice then falls into the bin. This causes the compressor to start and the water to flow, repeating the cycle. There are several methods of removing the ice sheets from the evaporator: some machines utilize only gravity; others push the sheet away from the evaporator with a metal finger; and in some the evaporator plate itself tilts, allowing the ice to drop into the bin.

In mold-shape evaporators, the ice is broken into cubes as it falls into the bin. Machines with flat evaporator plates, or cylindrical plates, drop the ice

sheet onto a heated grid of fine wire which melts the ice into cube shapes which then fall into the bin. A comparison between the two types of harvest machines and the flake machine is shown in Fig. A-1.

There is a significant difference in the properties of ice produced by the two basic types of ice machine. Pure ice is called 144 Btu ice. It requires 144 Btu of heat to melt one pound of pure ice. Harvest type machines produce 144 Btu ice. Ice produced by a flake machine is around 100 Btu ice. Thus harvest method ice has 30% more "cooling power" than flake ice.

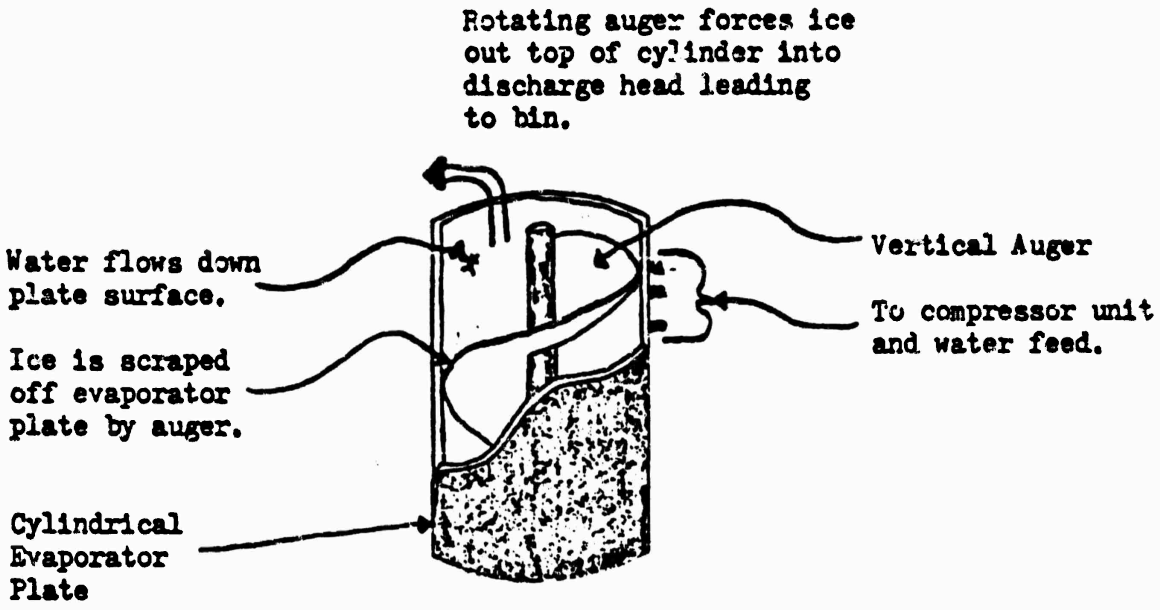
Other differences between the two types of machine are:

1. A flake machine costs less to operate than a harvest type;
2. A flake type machine costs less to purchase than a harvest type;
3. A water recirculation pump is not needed in a flake type machine as virtually all the water is converted to ice as it passes over the evaporator;
4. A flake ice machine is simpler in concept;
5. When a flake machine breaks down, it will probably require replacement of the vertical auger and/or main bearing. This is very expensive, and in some service agencies it has been found cheaper to replace the entire compressor and evaporator unit.

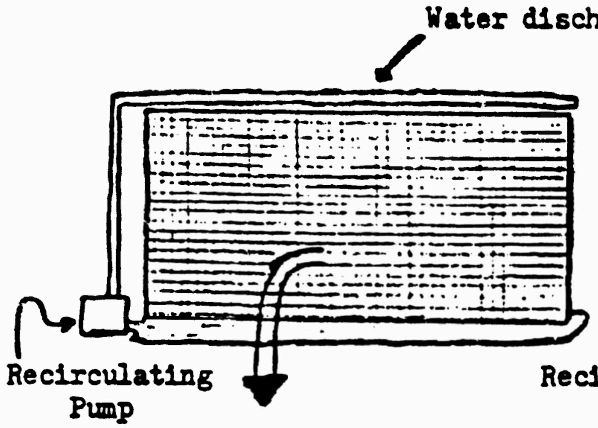
Ice maker condensor units may be either air or water cooled. A water-cooled unit is more effective and will improve the performance of the unit in high ambient temperature environments. Water consumption is high, however, and this cost plus increased sewage costs should be considered in selecting the ideal system.

Selection of one of the two types, harvest or flake, is dependent upon the intended use of the ice, and the type of operation it is to be used in. If the unit is to be replaced on a five-year remodeling plan, a flake ice machine may be adequate. If longevity is desired, a reliable maintenance program is essential. If the operation is capable of providing that type of service, and

Flake Type Ice Maker

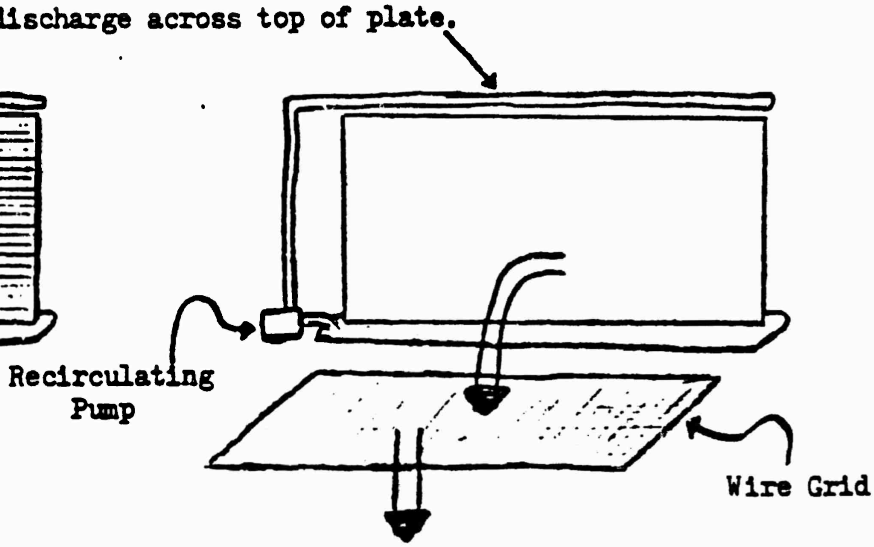


Patterned Mold Evaporator Harvest Type Ice Maker



During harvest ice drops from evaporator directly into bin. Force from the drop breaks the ice into cube shapes formed by the patterned mold.

Flat Sheet Evaporator Harvest Type Ice Maker



During harvest ice drops from evaporator onto heated fine wire grid. Fine wires cut ice into desired shape allowing it to drop into bin.

Figure A-1. Comparison between types of ice makers.

the abuse of the machine is limited, a heavier capital investment may be justified. One manufacturer has rated the typical lifespan of an ice maker as seven years.

Capacity. The amount of ice required in a specific operation is highly variable. It is dependent upon the amount of beverage service, the amount of service used for salad bars, etc., the demographic makeup of the clientele, the type of ice used, the ambient temperature of the operation, and many other factors. One manufacturer gives a rule of thumb figure of 1-1/2 pounds ice per dining room customer, and 3 pounds per cocktail lounge customer. These figures are very general, and a better guide is the current level of usage in a specific location.

Bin capacity is as important as ice machine production capacity. When the bin is full, the machine turns off. The bin needs to be large enough to carry the operation through its ice requirements during peak demand times. Rated bin capacity should be used only as a guide because ice mounds up under the drop point. The machine may turn off when the bin is only at 70% of its rated capacity.

Comparison Factors. When comparing ice makers, there are some factors which must be equated.

1. **Ambient air temperature and water supply temperature.** The air conditioning and refrigeration institute uses a standard of 90° F air temperature and 70° F incoming water temperature as reasonable guides for foodservice operations. Most manufacturers list the capacity of their machines at 70° F ambient temperature and 50 to 60° F incoming water temperature. These differences need to be accounted for in the machine comparisons.

2. **Energy Consumption.** This figure should be in terms of the final product produced. Kilowatt hours per hundred pound of ice produced is a common measurement.

3. **Horsepower.** The ultimate refrigeration is accomplished by the compressor. The horsepower rating of the compressor indicates the potential cooling capacity of the entire machine.

Accessories to be Considered

1. flake ice compactors
2. stacking units
3. ice pumps
4. dispensing units
5. heat exchangers
6. closed system water cooled condensers
7. incoming water filters
8. ice crushers

EVALUATION FORM FOR ICE MAKERS

Brand_____ Model_____

Flake type_____ Harvest type_____

NSF Approved_____ UL Approved_____

Compressor HP_____ Bin size _____lb

Energy Consumption_____ kWh/100 lb ice_____

1. Capacity: _____ lb per day at _____ degrees air temp.,
   _____ degrees water supply temp.

2.	Bin normal level of fill	(1-5)	_____
3.	Consistency and quality of product	(1-5)	_____
4.	Ease of operation	(1-5)	_____
5.	Compliance to health codes	(1-5)	_____
6.	Frequency of cleaning and maintenance	(1-5)	_____
7.	Amount of cleaning and maintenance	(1-5)	_____
8.	Ease of cleaning and maintenance	(1-10)	_____
9.	Durability and reliability		
	Bin and outer cabinet	(1-5)	_____
	Compressor unit	(1-5)	_____
	Evaporator dump	(1-5)	_____
	Water recirculation system	(1-3)	_____
	Water intake	(1-3)	_____
	Water coverage of evaporator	(1-5)	_____
10.	Energy efficiency	(1-5)	_____
11.	Warranty	(1-5)	_____
12.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of machine $_____

ICE MAKER EVALUATION FORM GUIDE

1. Capacity is not ranked. If proper capacity is not selected, none of the other criteria will be applicable.

2. Some bins approach their rated capacity closer than others. Shape of bin affects this, and some manufacturers use leveling devices to prevent ice from heaping under machine discharge. Rank the most effective bin utilization highest.

3. Evaluate the clarity of the cube, the consistency in size of cube, and the consistency of cubes throughout entire harvest.

4. Compare door openings for whether it can be opened with one hand, level of opening, depth to bottom of bin, and size of opening. Ideal will minimize bending and lifting.

5. Primary concern here is how easily ice can be reached. If head/shoulders must reach into machine to retrieve ice, sanitary compromises are being made. Interior surfaces, and door facings should be smooth with no sharp corners. The greater the radius or internal corners, the better.

6. All ice machines require periodic cleaning of the evaporator and water circulation systems to eliminate buildups caused by impurities in the water system. The frequency of cleaning will vary according to the quality of the water supply. Condensor coils must also be cleaned frequently. The manufacturer should indicate these requirements in its literature clains of maintenance. Maintenance-free machines may indicate a lack of follow-up concern about the machine. Rank an accurate estimate of maintenance requirements highest.

7. Amounts of cleaning and maintenance other than the aspects common to all ice makers may vary. Lubrication may be required, adjustments to water flow, calibration of timed cycles, and other factors may be called for. This amount should be minimized.

8. Ease of cleaning is one of the most important factors in ice machine selection. Maintenance points should be readily accessible. It should require only a few seconds to determine if the machine needs cleaning.

9. Durability is an extremely important consideration. Stainless steel bins and outer surfaces will hold up extremely well. Compressors should all be sealed units. Evaporator dump system should be simple in operation. The fewer moving parts the better. Water recirculation system should have a method of adjusting rate of flow. The pump should be a direct-drive unit with a screen to protect the impeller. Water intake should either have a filtration system or have a means by which one may easily be attached. Evaporator surface needs to be evenly coated with water. The type of distribution system may vary. Some systems flow water over the evaporator, others pressure-spray it. Pressure spraying results in a quicker freeze because of the smaller droplet size, but contaminants in the water supply tend to plug the nozzles easily. In general, a flow system with large holes is best.

10. This section can only be completed by ranking all machines evaluated. Compare kWh/100 lb ice produced. Rank the lowest energy user highest.

11. Warranty indicates manufacturer's commitment to his product. Compare and rank the most complete warranty highest.

12. Service in reality is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently small service businesses who must use answering machines or services are difficult to reach and they may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR ICE DISPENSERS

Ice dispensers move ice cubes from a holding bin into a "next use receptable." There must be a storage capacity of ice to be dispensed and some triggering method to release the ice when called for. Storage bins may be filled manually, as part of a self-contained ice maker/dispenser, or filled from a remote maker via an ice pump. Dispensing control may be coin operated, key controlled, or free access.

Intended use of the machine will affect the dispensing system selected. If the unit is to be used in a service line for dispensing of ice directly into glasses, a machine with free access is probably desirable. Important factors in this type of machine will be those that provide low volume dispensing with a minimum of wasted ice.

As the ice is dropping into a small receptacle, cubes must dispense individually as opposed to large clumps of ice. The dispensing chute is small enough to force this, but there must be some means of preventing clumping of ice as it is held in the storage bin. Agitation of the bin contents is the most reliable means of controlling this.

Dispensing is accomplished in several different ways. The majority use some type of impeller system to force ice into the dispensing chute. This impeller is typically made of plastic, with some flex in the blade ends. The dispenser may run continuously when the triggering mechanism is pushed, or for a timed cycle. In a timed cycle operation, the push-lever must be released and retriggered to dispense more ice. This provides a system of portion control. The most reliable system will be that which has the shortest travel path for ice from the bin to the end of the dispensing chute.

Critical factors in the dispensing of ice are reliability and efficiency.

Portion control, rate of flow, and discharge pattern of ice are primary factors affecting the efficiency of the dispenser's discharge. Select a machine that has variable portion control, a moderate flow rate, and a small discharge pattern. This will cause all the ice to be used in the beverages, instead of wasted in the overflow pan. A simple design of dispensing system is the ultimate factor in reliability.

Effeciency of the storage bin must also be considered. Ideally the machine must minimize the rate of melt. This may be ranked by comparing the type and amount of insulation in the storage bin. The access hatch or door to the bin should also be compared, both in terms of insulating quality and tightness of seal. Insulation around the dispensing mechanism should also be compared.

Sanitation is also important. Dispenser should be operable with only the glass contacting the push bar. The operator should not have to reach any more than the hand and wrist under the storage bin to activate the dispenser. All surfaces of the bin must be easily cleanable, both external and internal. The overflow tray must be large enough to hold all waste ice until it melts and is drained away without heaping up on the tray rack.

If the unit is self-contained, the ice maker portion of the unit should be evaluated according to the procedures outlined in the "Evaluation System For Ice Makers" portion of this report.

Capacity. Required capacity should be calculated according to the system described in the General Parameters section of this report. If the unit is self-contained, incoming water temperature and ambient air temperature must be compensated for as in ice makers. If the unit is filled automatically, either in a self-contained unit, or via an ice pump, the normal level of bin fill as opposed to the rated bin capacity must be determined.

EVALUATION FORM FOR ICE DISPENSERS

Brand_____ Model_____

NSF Approved_____ UL Approved_____

Self-contained_____ Modular_____ Remote_____

IF UNIT IS SELF-CONTAINED OR MODULAR, ALSO COMPLETE EVALUATION FORM FOR ICE MAKERS

1. Capacity: ____lb per day at _____ degrees air temp, _____ degrees water temp, _____ lb bin capacity

2.	Bin normal level of fill	(1-5)	_____
3.	Consistency and quality of product	(1-3)	_____
4.	Ease of operation	(1-3)	_____
5.	Safety and compliance to health codes	(1-10)	_____
6.	Frequency of cleaning and maintenance	(1-3)	_____
7.	Amount of cleaning and maintenance	(1-3)	_____
8.	Ease of cleaning and maintenance	(1-7)	_____
9.	Durability and reliability	(1-10)	_____
10.	Energy efficiency	(1-5)	_____
11.	Warranty	(1-5)	_____
12.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

ICE DISPENSER EVALUATION FORM GUIDE

1. Capacity is not ranked. If proper capacity is not selected, none of the other criteria will be applicable.

2. Some bins approach their rated capacity closer than others. Shape of bin affects this, and some manufacturers use leveling devices to prevent ice from heaping under machine discharge. Rank the most effective bin utilization highest.

3. Consistency and quality of product of a dispenser is primarily the accuracy with which it dispenses and the rate of melt within the dispenser bin. A simple, reliable dispensing mechanism is desirable, as is adequate insulation to allow holding of ice.

4. Ease of operation refers to the amount of labor required to fill the dispenser if it must be manually filled. Look for a large opening that may be easily opened. The opening should be at a convenient height.

5. As ice dispensers are typically self-service, sanitation considerations are very important. The machine should dispense ice without the operator having to touch the actual machine. Dispensing chute needs to be near the front of the machine. Machine should be easily cleanable. Drip tray should be large enough to accommodate normal amount of ice overflow.

6. External surfaces must be cleaned daily. All bins and dispensing units must be cleaned as per manufacturer's instructions. Compare, and rank a realistic statement of maintenance intervals highest, and excessive requirements, or so-called maintenance-free machine, lowest.

7. The number of tasks required to maintain the machine should be compared. This number will increase directly with the complexity of the dispensing unit. Rank a simple dispensing system highest.

8. Comparison of ease of cleaning requires examination of construction methods and materials. One-piece external coverings and bin liners are easiest to clean. Drip tray rack should be easily removed. Dispenser unit disassembly should require no tools, or very limited use of tools.

9. Reliability of the unit is critical. Dispensing unit motor should have sealed bearings and direct or gear drive. Simplicity is the strongest guide to reliability.

10. Energy usage of the dispenser itself is minimal. This comparison should concern the insulating qualities of the unit. Excessive loss of heat from the bin will result in faster melt and increased ice production costs.

11. Warranty indicates manufacturer's commitment to his product. Compare, and rank the most complete warranty highest.

12. Service, in reality, is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently small businesses who must use answering machines or services are difficult to reach, and they may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR TOASTERS

Toasting of bread is accomplished in one of two ways. Heat is either radiated to the surface of the bread, or it is transfered by direct contact with a heated plate. The simplest form of toasting by direct contact is placing buns on a griddle. This is effective in short order cooking, providing the griddle has been selected with adequate capacity to allow for toasting. Another direct contact toaster uses a heated vertical "blade". Buns are placed in the top, and as they drop through, the blade separates the heel from the crown. The two parts of the bun can be set to drop in the same place, or at two different stations. This type of toaster has a high capacity, around 700 slices per hour, and a relatively small number of moving parts.

The simplest form of a radiated toaster is the traditional pop-up toaster. These are manually operated and utilize a mechanical timer. Capacity is around 200 slices per hour. Another radiating toaster is a quartz-lamp-heated small oven. These typically hold 6 buns at a time and have a capacity of around 400 slices per hour. Traditional conveyor toasters are high capacity machines capable of up to 1000 slices per hour, which pass the bread past heat radiating elements by conveyor chain.

Selection of a type of toaster will depend upon capacity requirements of the specific location. Conveyorized toasting is not practical for small operations, and a pop-up toaster system would be unworkable in a high volume location. A radiated heat toaster will not compress the bread as a direct contact type toaster will. A fluffier product will result.

Major improvements have been made in the control of toasting. Electronic time and temperature controls are being used more frequently. They are very reliable if the ambient temperature is not too high. This is a major

consideration when selecting a toasting system. Optical sensors are also being used, which detect the degree of doneness by color. These are particularly effective in the quartz ovens, where the heat source can immediately be turned off electronically.

Capacity. Capacity requirements vary with the individual location. Selection of the proper capacity machine has been discussed in the General Parameters section of this report. Selection of multiple smaller, as opposed to one large toaster, may be desirable, as toasters are prone to breakdown. When comparing capacities of toasters, it is important to differentiate between whole bun per hour capacity and half bun or slice per hour capacity. The model selected must also be capable of handling the thickness of product to be toasted -- buns as well as slices of bread.

EVALUATION FORM FOR TOASTERS

Brand_____ Model_____

NSF Approved_____ UL Approved_____ Operating voltage_____

Direct contact heat_____ Radiated heat_____

Pop-up____ Conveyor_____ Top feeding_____ Oven_____ Other_____

1.	Capacity_____ slices per hour.		
2.	Consistency and quality of product	(1-15)	_____
3.	Ease of operation	(1-5)	_____
4.	Safety and compliance to health codes	(1-5)	_____
5.	Frequency of cleaning and maintenance	(1-3)	_____
6.	Amount of cleaning and maintenance	(1-3)	_____
7.	Ease of cleaning and maintenance	(1-5)	_____
8.	Durability and reliability	(1-10)	_____
9.	Energy efficiency	(1-3)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of machine $_____

TOASTER EVALUATION FORM GUIDE

Direct comparisons between types of toasters are not very valuable. This evaluation form should be used only to compare toasters of the same type. Selection of a particular type of toaster should be based on capacity requirements and consideration of the limitations of each type of toaster.

1. Capacity is not ranked. Accuracy of this calculation is critical, as none of the other performance criteria will be valid if the selected toasting system is not operating at proper capacity.

2. Consistency and quality of product is extremely important. Toasting is a very short cooking operation, so an error of a few seconds or a few degrees in temperature represents a significant portion of the cooking time and will drastically affect quality of product. Look for consistent temperatures and cycle times at a given setting, adequate control of settings, and reliable ejection of slices, or turn-off of heat source.

3. Ease of operation is a measure of automation. How much handling does each piece require? Labor requirements increase drastically if the product must be manually inserted into the toaster and manually removed.

4. Toasting is a high temperature operation. Heating elements should be shielded so the operator cannot be easily burned. Wiring should be heavy enough, insulated against heat, and hidden to prevent physical and heat damage.

5. Cleaning of crumbs must be done daily on all toasters. Wiping of spills and kitchen grime must also be performed daily. Maintenance tasks such as lubrication and tension of conveyor chains may vary in required frequency.

6. Amount of cleaning and maintenance will vary considerably between types of toasters. As comparisons between types of toasters should not be done, the amounts should be compared within the categories of toasters. Conveyor types require the greatest amount of maintenance, so the most variability will be encountered with these machines. Compare the total number of tasks required.

7. Again, this factor will be most important in conveyor type toasters. Consider the amount of disassembly required and the number and kind of tools required to maintain the toaster.

8. Toasters have small heating elements which are heated to extremely high temperatures. Continual heating and cooling can warp heating elements, cause them to break down, and make wiring brittle. Conveyor chains also become brittle, break, and stretch due to heat and constant rotation. Select a machine for heavy gauge wiring and conveyor chain, and a maximum amount of heating elements.

9. Energy utilization levels within each type vary considerably. Total energy use of toasters is a very small portion of kitchen energy costs. There is no uniform method for comparing energy consumption of toasters. Thus, comparisons are not very accurate and should not be relied upon heavily.

10. Warranty indicates manufacturer commitment to his product. Compare and rank, with the highest score reflecting the most complete warranty.

11. Service, in reality, is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently small businesses who must use answering machines or service are difficult to reach, and they may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR CONVECTION OVENS

Convection ovens use dry heat to cook. The significant difference between a conventional oven and a convection oven is that a convection oven forces hot air past the product. This moving air removes the insulating blanket of air that ordinarily forms around a food product. Consequently foods cook quicker. Moisture collects on the surface of some foods. This must be boiled away before the temperature of the food product can rise above 212 degrees. The movement of air increases the evaporation rate of this moisture. The oven can be set at a lower temperature thus saving energy. Because of the moving air, oven temperatures are more consistent throughout the oven. This allows heavier loading, and more of the interior space of the oven can be utilized. The drying effect of the moving air can, however, cause excessive shrinkage and drying of some products.

Convection ovens are available in gas and electric models. A full-size oven holds full sheet pans while still allowing proper air flow around the pan. Counter models, or half-size models are available, which accept only smaller pans. Roll-in rack ovens permit volume production under convection conditions.

A significant feature that should be considered is a cook-and-hold option. This permits a product to be cooked at one temperature and automatically held at a lower temperature after a selected period of time. Cooking can be done overnight when electricity demands are not as high as during peak periods. Some cook-and-hold options offer only a preset holding temperature, while others are adjustable. Blower action varies between models also. Some stay at full speed during hold, others drop to half speed, while still others are in operation only when heating elements are on.

Doors are available as either single opening, double opening, solid, or glass fronted. If a single door is selected, consideration should be given to the direction the door opens with respect to the oven's location in the kitchen. Glass fronted doors are not as well insulated as solid doors, but if they are kept clean, the product may be inspected without opening the door, thus saving energy.

Capacity. Capacity as listed by manufacturers is potential cooking capacity. A capacity listing should include per product: weight per piece, pieces per pan, number of pans per load, temperature setting, cooking time, and degree of doneness. Theoretical capacities are influenced primarily by loading and unloading times. Once the oven is loaded, it will cook at or near the manufacturer's potential capacity. An individual operation's capacity should be calculated according to the procedure outlined in the General Parameters section of this report.

EVALUATION FORM FOR CONVECTION OVENS

Brand_____ Model _____

NSF Approval_____ UL Approval_____ AGA Approval_____

Gas ____ Electric____

Size_____ Solid door_____ Glass door_____ Door opens:_____

Cook and hold option_____

1. Capacity: Item_____ pan load_____ weight per piece_____ temp setting_____ cooking time_____ degree of doneness_____

2.	Consistency and quality of product	(1-5)	_____
3.	Ease of Operation	(1-10)	_____
4.	Safety and compliance to health codes	(1-5)	_____
5.	Frequency of cleaning and maintenance	(1-5)	_____
6.	Amount of cleaning and maintenance	(1-5)	_____
7.	Ease of cleaning and maintenance	(1-5)	_____
8.	Durability and reliability	(1-10)	_____
9.	Energy efficiency	(1-5)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

CONVECTION OVEN EVALUATION FORM GUIDE

1. Capacity is not ranked. Adequate capacity must be calculated to satisfy operation's specific needs. Failure to do so will negate the value of other criteria used in machine evaluation.

2. This is difficult to evaluate without being able to perform oven tests. Primary concern is temperature consistency in all areas of oven.

3. Some uses of convection ovens require frequent access to the oven. Doors should be counter-balanced for easy opening. Controls need to be readily accessible and easy to read. Windows in doors simplify inspection of product. Racks that slide out easily and have stops so they can't be pulled all the way out are preferred. External thermometers provide easy reading of temperatures.

4. Safety is an important consideration. Handles should remain cool to the touch, vents should discharge air away from the operator. The blower motor must shut off when the door is opened.

5. The interior oven surfaces must be cleaned on an as-needed basis. The fan and baffle system must be cleaned according to the manufacturer's specifications. Different fan and baffle systems collect grease at different rates, and this will affect frequency of cleaning. If the blower motor and door hinges require lubrication, this frequency must be compared.

6. The number of points that must be maintained regularly should be compared. This should include door hinges, counter-balance cables, blower motor, temperature calibration, and surface area to be cleaned.

7. The two most critical maintenance points are the blower motor and the door hinges. Both should be easily accessible. Interior corners should be rounded. The greater the radius the better. Outside panels that are in one piece are more easily cleaned than sectioned panels. Interior surface must be smooth and non-absorbant.

8. Heating elements need to be constructed of alloys that do not warp. Hinges should be as heavy as possible. Wiring and manifolds that are shielded will not be damaged by cleaning. Ceramic portions of construction must be hard and non-absorbant.

9. Energy utilization is a comparison between machines evaluated. The ASTM provides specifications for energy consumption. These should be used to rank each machine.

10. Warranty indicates manufacturer's commitment to his product. Compare, and rank the most complete warranty highest.

11. Service, in reality, is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently, small businesses who must use answering machines or services are difficult to reach, and they may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR RANGE TOPS

Ranges provide surface heating for cooking in pots and pans. They have the ability to heat to very high temperatures. The element, or portion of the range providing the actual heat transfer, may be one of several types. Energy supplied to the range may be either electric or gas. Typical range sizes are 24 inches deep by 36, 48, or 72 inches wide. These widths are preferred as the usual configuration of the range is with a single (or with the 72-inch ranges, double) deck oven under the range top. A width of less than 36 inches would not permit use of an oven which could accommodate a standard 18- by 26-inch sheet pan.

Electric range tops are in one of two forms: the hot top or separate elements. Hot tops are flat metal plates covering the entire range top. The total surface area of the plates is heated by elements either imbedded in the plate or clamped to it. The range top is usually covered by separate 12-inch-wide plates all linked together to provide a continuous flat top. Each plate is controlled by a separate thermostat. Thickness of the plates may range from 1/2 inch to 1 1/2 inches. The thicker plate will provide more even heat, while the thinner plates will recover lost heat quicker. Preheat time and time required to adjust temperature are extremely long with an electric hot top. Hot tops provide excellent versatility in placement of pots and pans, but they are relatively inefficient energy users. Efficiency will be greatly boosted if the pans used are of high quality with pan bottoms extremely flat. Bent pans do not allow a large enough surface area for optimal heat transfer. A typical 12-inch-wide plate will require from 5 to 5-1/2 kW heat input.

Separate electric elements are tubular or flattened tubular metal elements encasing resistance wire. They may vary in diameter from 6 inches to

10-1/2 inches. A typical arrangement has a front and rear element for every foot of range width. Elements are more fragile than hot tops, and may break if excessive weights are placed upon them. In addition, heating an element with no cooking load can cause it to warp to the fracture point. Elements are more efficient than hot tops as they may be switched off when not in use, and only the round element as opposed to a rectangular plate is heated. Thus only the area actually in use is heated. Since there isn't such a large mass of metal to heat, the electric element responds to thermostat adjustments much quicker than a hot top. Typical heat inputs per element range from 2 1/2 to 3 1/2 kW.

Electric ranges may be purchased with part of the surface as a griddle. Any combination of griddle, hot top, or elements may be selected to make up a specific range top.

Gas ranges are also available with hot tops, open top burners, or as griddles. Again, the solid top range is a plate varying from 1/2 to 1 1/2 inches in thickness. Heat is applied via open flames to the underside of the flat top. Some units will have the underside ribbed to provide more surface area for heat transfer. Gas powered hot tops respond faster than electric hot tops to temperature changes, but they are still relatively slow to heat up. Heat inputs into a 12-inch plate will range from 15,000 to 25,000 Btu. The chief advantage of the hot top is freedom to place pots and pans anywhere on the unit's surface, and its ability to support very heavy weights.

Open top burners have the advantage of providing instant heating to the pan. As the heat transfer is directly by flame to the pan bottom, the unevenness of the pan bottom has little effect on heating. Temperature variations are visible as changes in flame size and color. As the flame is turned down however, the surface area heated is reduced, concentrating heat in the center of the pan. Work is being done on burners which pulse on and off to

provide lower levels of heat. This allows low temperature cooking while heat is applied to a large surface area. Typical heat input into an open top burner is 15,000 to 20,000 Btu.

Specialty units such as stockpot ranges are also produced. These provide heat to a greater surface area, and heat inputs from 30,000 to 80,000 Btu are used. These units are capable of heating to over 1000 degrees F.

Other features that should be considered - ready access of all parts for cleaning, convenient controls, and comfortable work top height. Some units that use large stock pots consistently may be placed in floor recesses, which will allow the lip of the pot to be more easily reached. All external surfaces must be easily cleanable. Electronic ignitors on gas units can produce extensive energy savings. Many ranges are being sold with casters to promote easier cleaning.

Capacity. Capacity should be calculated according to the procedures outlines in the General Parameters section of this report. Other factors specific to the range top capacity selection are: initial temperature of liquids used, available input heat, pot material, pot thickness, shape and size of pot, flatness of pot bottom, cooking temperature, and use of a cover on the pot.

EVALUATION FORM FOR RANGE TOPS

Brand _____ Model _____

NSF Approval _____ UL Approval _____ AGA Approval _____

Type of Top: Hot _____ Open burner/element _____ Griddle _____

Combination top _____

Energy input: _____ Btu (kWh)/sq. in. _____ Btu (kWh)/burner

1. Capacity: _____ sq. in. top surface _____ burners (elements)

2.	Consistency and quality of product	(1-5)	_____
3.	Ease of operation	(1-3)	_____
4.	Safety and compliance to health codes	(1-5)	_____
5.	Frequency of cleaning and maintenance	(1-5)	_____
6.	Amount of cleaning and maintenance	(1-3)	_____
7.	Ease of cleaning and maintenance	(1-5)	_____
8.	Durability and reliability	(1-10)	_____
9.	Energy efficiency	(1-5)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

RANGE TOP EVALUATION FORM GUIDE

1. Capacity is not ranked. If proper capacity is not selected, none of the other criteria will be applicable.

2. A range top provides a heated contact surface for heating pots and pans. Consistency and quality of product will thus only be affected by deviations from the temperature setting selected. This can occur with a nonstable gas flow, inaccurate thermostats, or inadequate energy input.

3. Range tops must be at convenient height. This for most uses is between 32 and 36 inches from the floor. Controls should be easy to reach and large enough to be turned easily.

4. The range top by nature has an exposed hot surface. Safety can be improved by providing cool zones around the unit top protecting the operator who may brush against it. Controls should be well insulated against heat. External surfaces should be easily cleanable with as few joints as possible.

5. All external surfaces of the range top must be cleaned. Other tasks include maintenance of the gas jets, thermostat calibration, and cleaning of under burner area. Compare manufacture requirements and provisions on the machine which prevent spills from dropping into inaccessible places.

6. Number of tasks involved in maintaining the unit must be compared. Compare manufacturer's recommendations.

7. With range tops, variability in ease of maintenance refers to one-piece external surfaces, burners which may be easily accessed, and controls which are beveled and mounted in a manner that prevents dirt from becoming lodged behind them.

8. A range top is a multiple use machine, and typically irreplaceable in most kitchens that use one. Reliability is essential. The unit must be suited for its intended use. Elements must be able to support weight of pots placed upon them. Primary cause of failure is inadequate capacity of the machine for its intended use.

9. Range tops use large amounts of energy. A gas model with electronic ignition as opposed to pilot lights is preferable. Compare manufacturer's specifications on energy usage.

10. Warranty indicates manufacturer commitment to his product. Compare, and rank the most complete warranty highest.

11. Service, in reality, is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently small service businesses who must use answering machines or services are difficult to reach, and they may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR TILTING FRY PANS

A tilting fry pan, or tilting skillet is an extremely versatile piece of equipment. The machine is typically rectangular, with the entire bottom surface heated by one of several means to a wide range of controllable temperatures. Sides are attached to the skillet surface and range from 7 inches in height to 9 inches. A cover is provided, which is usually rear hinged and counter-balanced. Pans may be wall-mounted, floor-mounted, or cabinet-mounted. As the name implies, the skillet tilts, either by lowering the front edge, or raising the rear of the skillet to allow product to be tipped out. Some sort of pouring spout is incorporated into the front edge of the skillet to allow control of product flow. Tilting mechanisms may be hand levers in very small counter-top units, hand gear-controlled units, or in very large pans, electrically operated gear tilts. Heat source may be electric or gas.

The skillet bottom may vary in thickness from 3/8 inch to 1 inch. This is reflected in the machine's performance. A thicker pan bottom will have a slow recovery time, but more even heat distribution across the total surface of the pan. A thinner surface will sacrifice some of the heating consistency, but greatly improve the recovery time of the equipment. The food contact surface of the skillet typically is stainless steel, or copper plate. Copper plating provides better heat distribution, but is not as durable a working surface as stainless steel.

Selection of an energy source depends primarily upon the intended placement of the skillet. It must be compatible with other equipment in the facility. As the machine is extremely versatile, it may be advantageous to wheel-mount the unit to allow movement of the machine from a cooking area to a

serving/holding area. If this is done, quick-disconnect gas feed lines and electric lines will be required. Ideally, heat inputs into the heating surface should be around 120 Btu, or 24 watts, per square inch of heating surface. This may not be possible with units currently on the market. Because of this limitation in heat power, the unit will have an extremely slow recovery time if used for deep fat frying.

Temperature control is accomplished by use of a single thermostat. Top end temperature may vary between manufacturers. This is of importance to the evaluator as a top end temperature higher than necessary may result in higher energy utilization, while some cooking operations may be excluded if temperature is too low. Accuracy of the thermostat should be within 5 to 10 degrees F, and the temperature cycle swing should be no more than 40 to 50 degrees F. For operator and unit protection, there should be a high-temperature limiting switch to protect against failure of the thermostat.

Floor-mounted pans have a clear span area under them allowing for easy cleaning of floor areas. Typically the frame required makes the space required for a floor-mounted pan wider than for a cabinet-mounted model of equivalent capacity. Floor-mounted skillets also tilt by lowering the front edge of the pan, or by pivoting the pan about a central axis. Thus, product removal is at a lower height than the working height of the pan. This may cause operator discomfort, and stands for product removal may be desirable. Cabinet-mounted skillets dispense product by raising the back of the pan. This allows product to be drawn off at the normal working height of the pan. Cleaning under the pan is more difficult than with floor-mounted units. A wall-mounted skillet provides the easiest access for cleaning, but cannot be moved to a serving area. Space requirements will be similar to those for a floor-mounted pan. Supplemental wall supports may be required to provide sufficient wall strength

to support the skillet. Counter top models are very small, designed for supplementary use in large kitchens, or for use in small operations. Energy use per pound of product produced will be higher than in larger models, but other performance characteristics will compare with larger models. Working height of these pans will be above a comfortable height.

Covers should fit tightly against the skillet sides to allow maximum heat retention. Some models are available with a vented cover, and this may be desirable in some operations. All covers should tip easily and be secure in the up position. This is most reliably accomplished by counter-balancing the cover so it is well past the balance point when the lid is raised. The handle on the cover should be insulated against heat, and the position the operator normally stands in when the cover is raised should be such that steam is directed away from the operator's hands and body.

Capacity. Selection of the proper capacity machine should be done as described in the General Parameters section of this report. Tilting skillets are available in sizes ranging from 15 to 40 gallons. These capacities are absolute, and a head space of 10 to 15% should be allowed. Recovery time of the unit will vary for different cooking operations, and this must be included in the calculations of capacity.

EVALUATION FORM FOR TILTING FRY PANS

Brand _____ Model _____

NSF Approval _____ UL Approval _____ AGA Approval _____

Mount: Floor ____ Wall ____ Cabinet ____ Counter ____

Heat input: _____ Btu (kWh)/sq. in.

1.	Capacity: _____gallons		
2.	Consistency and quality of product	(1-7)	_____
3.	Ease of operation	(1-5)	_____
4.	Safety and compliance to health codes	(1-10)	_____
5.	Frequency of cleaning and maintenance	(1-5)	_____
6.	Amount of cleaning and maintenance	(1-3)	_____
7.	Ease of cleaning and maintenance	(1-5)	_____
8.	Durability and reliability	(1-7)	_____
9.	Energy efficiency	(1-10)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

TILTING FRY PAN EVALUATION FORM GUIDE

1. Capacity is not ranked. If proper capacity is not selected, none of the other criteria will be applicable.

2. Tilting fry pans are extremely versatile machines. Consistency throughout all operations of the pan include even heating of the pan bottom and requires a small thermostatic temperature cycle at any given setting. Thermostat must have a wide range of available temperatures.

3. The pan should be at a convenient working height. Tilting mechanism must turn easily and with one hand. Machine may be mounted on casters with quick-disconnect power hookups.

4. Tilting fry pans are large pieces of equipment, and weights of product and the machine iteslf can make them very dangerous. The tilting mechanism must have a positive stop. Gear teeth should be deep enough to ensure pan cannot slip and ratchet to full tilt. Cover handle should be non-heat-conductive, and be positioned so steam is directed away from operator when opened.

5. All surfaces of the machine must be cleaned daily. Other maintenance tasks are primarily lubrication of cover pivots, tilting pivots, and gear mechanism. Thermostat calibration must be periodically performed.

6. The number of steps required to lubricate the entire machine must be compared.

7. All surfaces should be rounded and easy to wipe. Pouring spout may be removable, and this will aid in cleaning. Cover may be removed for cleaning. or it may be cleaned in place. Cleaning in place requires reaching across the machine, while cover will be heavy and difficult to handle if removed. The amount of disassembly required to maintain the machine should be compared.

8. A tilting fry pan must be able to manipulate heavy loads of product. Construction should be of heavy gauge stainless steel. Gear tilts must be large enough and gear teeth deep enough to withstand continuous tilting. Whenever the pan is fully tilted, there is extreme lateral pressure exerted on the gear intersections. Heat input should be great enough to allow unit to come to selected temperature, permitting the thermostat to shut the heat source down.

9. Energy inputs can be directly compared. These must be related to product produced per unit of energy input for energy efficiency studies. Compare these ratings between machines. Electronic ignitors for gas units will decrease gas consumption. Fit of cover and tightness, along with method of heat application to pan bottom will affect heat loss. The cooler the frame, sides, controls, etc. when the pan is in operation, the less heat being lost.

10. Warranty indicates manufacturer's commitment to his product. Compare, and rank the most complete warranty highest.

11. Service, in reality, is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently small service businesses who must use answering machines or services are difficult to reach, and they may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR SHELVING

Shelving may be divided into four categories: dry goods, cooler, can racks, and dunnage. Although similar, there are a few differences between each type and the function it is designed to perform.

Can racks are an efficient system for storage of #10 and #5 cans. Cans are stored on their sides and rolled in at the top of the rack. They roll through an "S" shaped path dropping through the rack until they hit the can in front of them. Cans are used from the bottom of the rack. This provides automatic inventory rotation. External dimensions of can racks are similar to other types of dry storage shelving making them compatible with other facets of a shelving system. As there is little space required between the folds of the "S", space utilization is extremely efficient.

Dry goods shelving typically is rectangular in shape, although there is great variation in available sizes. Shelves may be solid surface or open wire construction. There should be a great deal of versatility in selecting vertical shelf spacing, and this should be adjustable at the location to allow for maximum utilization of available cubic space.

Cooler shelving is similar to dry goods shelving with the exception that the construction material will be treated to withstand the high humidity levels of a cooler.

Dunnage shelving is typically of open wire construction to allow the passage of air to the product. There will be only one shelf on short legs to permit easy handling of heavy materials.

Selection of required shelving must be geared to the physical space available, and the amount of goods to be stored. Construction material typically is plated steel, with welded joints. Some shelving is plastic

coated. This provides good protection and is easily cleanable; however, as the plastic is frequently damaged, there should be some protective coating on the metal under the plastic. Open shelving allows passage of air around the product stored, but if there is a spill the contents of the shelves below the spill will be contaminated. Solid shelving is easily cleanable, but allows no air circulation. An alternative to these possibilities is ribbed solid shelving. This prevents spills from dropping to other shelves, allows limited air movement around product, and is easily cleanable.

Solid shelving increases the weight of the shelving unit, and it may affect the load capacity of the unit. Load capacity per shelf should be compared between comparable units.

Adjustments to shelf spacing should be easily accomplished, and no tools should be required. Side supports are available for most units, and they will prevent pushing product off the shelf. As dry goods and canned products typically are of high density, total weight on the shelves will be quite high. Systems used to provide corner stability, as well as the fastening method, should be compared. Some manufacturers are providing casters for shelving units. This increases the versatility of the unit and promotes better cleaning of floor areas. If casters are selected, they should be hard rubber, and have a sufficient load bearing capacity for the anticipated product load.

EVALUATION FORM FOR SHELVING

Brand _____ Model _____

NSF Approved _____

Type: Dry goods _____ Cooler _____ Dunnage _____ Can rack _____

1.	Capacity: _____lb/shelf _____ sq. in. storage/shelf		
2.	Consistency and quality of product	(1-5)	_____
3.	Ease of operation	(1-3)	_____
4.	Safety and compliance to health codes	(1-5)	_____
5.	Frequency of cleaning and maintenance	(1-3)	_____
6.	Amount of cleaning and maintenance	(1-5)	_____
7.	Ease of cleaning and maintenance	(1-5)	_____
8.	Durability and reliability	(1-10)	_____
9.	Warranty	(1-5)	_____
	Total Rank Points		_____

Cost of Shelving $_____

on the cover of the machine, or it may be operated by a small electric motor in larger units.

Frame typically is of tubular steel and painted, or it may have a baked-on enamel. Bowls of the smaller units are stainless steel and aluminum on the larger units. Motor cover may be painted, baked-on enamel, or stainless steel.

Controls will be side-mounted and easily reachable. A unit should be purchased that has a stop button, which may activated by pushing, rather than turning or flipping. This allows power to be cut off quicker, in the event of an emergency. Controls will have only a low and high speed. If the mixing baffle is electrically operated, there will be a separate switch for this purpose.

Vertical cutter/mixers can be extremely dirty machines to use. For cleaning purposes it is recommended that the larger machines be located with their own floor drain and water supply. Electric supply lines must also be isolated because of the large amount of current required to operate the machine.

Capacity. Capacity of the vertical cutter/mixer may be calculated according to the procedures outlined in the General Parameters section of this report. When calculating the capacity, the evaluator must realize that the machine's capacity, once it is loaded, will be a false indicator of the machine's performance. As the actual cutting operations are so fast, more time is spent loading, unloading, cleaning, and setting up the machine than actually operating the machine. Determine capacity by considering the full cycle time from setup to product unloading for a batch time.

EVALUATION FORM FOR VERTICAL CUTTER/MIXERS

Brand _____ Model _____

NSF Approval _____ UL Approval _____

Horsepower: Low speed _____ High speed _____

1.	Capacity: _____ quarts		
2.	Consistency and quality of product	(1-3)	_____
3.	Ease of operation	(1-5)	_____
4.	Safety and compliance to health codes	(1-7)	_____
5.	Frequency of cleaning and maintenance	(1-3)	_____
6.	Amount of cleaning and maintenance	(1-3)	_____
7.	Ease of cleaning and maintenance	(1-5)	_____
8.	Durability and reliability	(1-10)	_____
9.	Energy efficiency	(1-5)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

VERTICAL CUTTER/MIXER EVALUATION FORM GUIDE

1. Capacity is not ranked. If proper capacity is not selected, none of the other criteria will be applicable.

2. Consistency and quality of product is not very important with vertical cutter/mixers. As the blades work so fast, most deviations in quality of product will be operator faults rather than machine flaws.

3. Cover on the vertical cutter/mixer should tip up easily and stay in the up position. A wing nut on the shaft end will make changing blades easier. Tilt lever should be long enough to allow adequate leverage when dumping product. Controls should be large and easy to use.

4. Vertical cutter/mixers use extremely sharp blades at a very high rate of speed. Cover must positively lock down, and an interlock switch must prevent power from being applied unless cover is locked. Off switch should be a panic push-button type. All external surfaces should be smooth and rounded.

5. Maintenance tasks are minimal. Daily cleaning must be done, and other tasks such as periodic lubrication should be compared with other manufacturers for recommended frequencies.

6. Motors are sealed, so there is little maintenance to be done to them. Lubrication of pivot points, lubrication of the central shaft, and sharpening of the blades comprise the majority of maintenance tasks. Compare with other manufacturers.

7. Ease of cleaning may vary among manufacturers. Compare steps required for disassembly of blade and bowl removal. Cover should have no ledges or projections to hamper cleaning.

8. Vertical cutter/mixers are heavy duty machines. Their durability typically is very high. Frame must be very sturdy as there is great torsional force exerted when the machine starts. Motors are heavy enough to last indefinitely. Stainless steel construction will be most durable.

9. Energy consumption is not a major concern. The units draw large amounts of current when switched on, but they are on for such a short period of time that they have little effect on total energy use.

10. Warranty indicates manufacturer's commitment to his product. Compare, and rank the most complete warranty highest.

11. Service, in reality is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently, small service businesses who must use answering services or machines are difficult to reach, and they may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR SLICERS

Slicers, as the name implies, are used in the slicing of all types of food products. The blade is a disc, which is turned by an electric motor at around 350 RPM. Food product is pushed across the blade with a product carriage mechanism. This carriage may be horizontal, vertical, or on an angle. Most general-purpose slicers have carriages on an angle. The carriage may be hand- or power-operated. At rest, product sitting in the carriage rests against a gauge plate. This plate can be raised and lowered altering the thickness of the slice when the carriage is pushed across the blade. Product falls into a receiving tray from which the operator removes it. Material to be sliced may slide down the carriage towards the blade by gravity, or it may be force-fed. There typically will be a product retention clamp to hold product in place on the carriage.

Depending upon the size of the slicer, the motor will range from 1/2 horsepower to 5. Automatic feed options use a small auxiliary motor to drive carriage. Carriage speed may be adjustable in fixed increments such as high and low, speeds 1 to 5, etc., or it may be possible to select an infinite number of speeds with a dial control.

Speed reduction from motor RPM to blade RPM may be accomplished with gears or belts. Gears are preferable, as there is less probability of failure. All bearings and gear mechanisam in the drive unit should be sealed and permanently lubricated. Motor housing should be completely sealed from dirt and spilled food product. All ventilation openings for the motor to allow for cooling should be under the platform.

Slicer should either rest on legs high enough to allow for easy cleaning underneath, or have some method of lifting the machine away from the work surface to allow easy cleaning underneath the machine.

Blade will be either carbon steel or stainless steel. Diameter of the blade may range from 10 inches to 18 inches. The edge of the blade may be hollow ground, or bevel ground. Some slicers utilize a concave blade. Blade sharpeners attached to the machine, permit accurate sharpening of the blade. These utilize the drive motor to turn the blade while the stone hones the blade edge.

Controls of the slicer should be within easy reach, and the stop button should be a push type panic stop. Blade guards and shields must be removable for cleaning. Nuts to loosen them must be large enough to grip them and turn them by hand. Threads should be coarse enough and deep enough to stand continual adjustment. The metal, from which the bolts and threaded receptacles are constructed, should be hard enough to resist cross threading.

Capacity. Slicers have an easily calculable working rate. The carriage moves at an automatic fixed speed. This will provide an inaccurate measure of slicing capacity, however. Calculate the time needed for the total slicing operation -- from setting up the machine, to adjusting the product while it is in the carriage, to removal of the product from the receiving tray. Use this cycle time in the calculations described in the General Parameters section of this report.

EVALUATION FORM FOR SLICERS

Brand _____ Model _____

NSF Approval _____ UL Approval _____

Voltage _____

1. Capacity: _____ in. blade diameter _____ strokes per minute

   _____ in. maximum slice thickness

2.	Consistency and quality of product	(1-5)	_____
3.	Ease of operation	(1-5)	_____
4.	Safety and compliance to health codes	(1-7)	_____
5.	Frequency of cleaning and maintenance	(1-5)	_____
6.	Amount of cleaning and maintenance	(1-3)	_____
7.	Ease of cleaning and maintenance	(1-10)	_____
8.	Durability and reliability	(1-5)	_____
9.	Energy efficiency	(1-3)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

SLICER EVALUATION FORM GUIDE

1. Capacity of a slicer is difficult to evaluate, as most of the determining factors are operator determined as opposed to machine determined. Capacity is not ranked. If proper capacity is not selected, none of the other criteria will be applicable.

2. Quality of product produced can vary greatly. Carriage speed may be constant, but blade edge, product differences, and thickness of slice will affect consistency of product. Primary machine variable is sharpness of blade. Select a high quality blade which will hold an edge, and a reliable sharpening system.

3. Slicers require considerable manual attention. Carriage handle should be slightly below elbow level. Carriage should move easily, and the thickness control should move smoothly.

4. Safety is an important factor. Off switch should be a push-button panic type. Guards must be removable for cleaning, but provisions should be made to ensure hands are clear of blade when handling guards. A slicer is a quiet machine, and its motor may not be heard over kitchen noise. Therefore, there should be a power-on pilot light indicating that the machine is turned on.

5. Slicers must be cleaned every time they are used. Other maintenance tasks are blade sharpening, lubrication of carriage slide, and lubrication of gauge plate adjusting mechanism. Compare manufacturers' recommendations.

6. Amount of maintenance will vary only in the number of lubrication points in the carriage and gauge plate. These differences will be small.

7. Ease of cleaning is critical. Machine must be wiped down several times a day. Compare smooth surfaces, rounded edges, and internal corners. Compare provisions for cleaning under machine. Guard retaining bolts must be removable by hand.

8. Durability and reliability of a slicer is not as important as some of the other considerations. There will be considerable wear of carriage system from constant use, and blade will be worn away. Motors seldom fail. Primary cause of replacement is mechanical metal fatigue. Most larger operations have more than one slicer, so if one does fail, it can be compensated for.

9. Slicers are small energy users, and there is little opportunity for improving their performance in this category.

10. Warranty indicates manufacturer's commitment to his product. Compare, and rank the most complete warranty highest.

11. Service, in reality, is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently, small service businesses, who must use answering machines or services, are difficult to reach, and they may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR DEEP FAT FRYERS

Deep fat frying involves immersion of food product completely in hot oil. The oil reservoir is large enough to transfer heat to the food product and still maintain a high temperature. Heat may be from electric elements immersed in the oil, by gas flames on the exterior of the reservoir, or large tubes that pass through the fat container. Temperature will be controlled by a thermostat.

Food product will be introduced to the fat via a wire basket. This basket should be constructed so fat will flow through it easily. Structure of the basket will be welded or pressed metal mesh. Metal must be noncorrosive.

Current fryers frequently are produced with timed lift-out devices. If the unit is to be used for one product and portion size, these can be very effective. Timing device typically will be solid-state controlled.

Fry kettles are different shapes. Shallow kettles maximizing surface area are best for products such as doughnuts, while denser potatoes are better fried in a kettle which minimizes surface area, but has depth to provide a sufficient amount of stored heat energy. Frying operations that produce large amounts of debris should be equipped with a cold zone to trap solids and prevent their contacting all the oil speeding its breakdown. Some cold zones are produced with a crumb tray, which allows frequent removal of debris. Products high in water content should not be fried in machines with cold zones, as water resting in the cold zone can be stirred to the point where it contacts the hotter oil causing a steam explosion.

Frying requires fast recovery for most operations. For this reason, the amount of heat input must be very great. Typical heat inputs into fryers are 2500 to 4000 Btu per pound of fat, and around 1 kw per 2.5 pounds of fat in electric models. If heat inputs are at levels listed here, the machines should be capable of frying one part food to six parts fat by weight. Most units heat the oil by a large amount of heat upon a relatively small surface area. This heats some of the oil to very high temperatures causing premature breakdown. Applying heat to a greater surface area while lowering the amount at any given point will prolong the life of the fat.

Fryer height should be such that the kettle lip plus the height of the basket are just below elbow level. Fry kettles also should, where possible, be at the same height as surrounding equipment to enhance flow of the line.

Fryers may be constructed of mild steel, or stainless steel. Stainless is more durable and can take hard cleaning better than mild steel. Stainless steel fryers will cost around 20 percent more than mild steel units. Kettles usually are 18-gauge, as are the cabinets. Legs should be used that mount the fryer at least 6 inches above the floor to permit cleaning under the unit. An alternative to legs is to seal the unit to a platform on the floor.

Controls need to be easily accessed. Handles of controls must be in a location where they can be seen easily and out of the way of hot areas of the fryer. A pilot bulb should be visible so the operator can determine the actual temperature of the fat easily, especially if frying is done by time cycles. The thermostat must be accurate to within 5 degrees to allow

consistent results. The fryer must also have a backup safety thermostat to shut down the unit, if the primary thermostat fails. Installation of the fryer is recommended with the use of a separate power or gas cutoff away from the location of the unit. If the fry kettle catches fire, power may safely be removed.

Energy may be conserved in frying by insulating the kettle. Covers are also available which limit heat loss while the unit is at rest.

Capacity. Fryer capacity should be calculated according to the procedure outlined in the General Parameters section of this report. Determining capacity of fryers requires consideration of both kettle size and recovery time. Factors unique to frying are primarily recovery time and anticipated product most frequently fried. One expert in the field recommends that a fryer should be able to fry 1.5 to 2 times its fat capacity per hour.

EVALUATION FORM FOR DEEP FAT FRYERS

Brand _____ Model _____

Electric _____ Gas _____

NSF Approvel ____ UL Approval ____ AGA Approval ____

Energy input: ____Btu/lb fat _____kWh/2.5 lb fat

Cold zone: yes ___ no ____

1.	Capacity: _____ lb fat		
2.	Consistency and quality of product	(1-7)	_____
3.	Ease of operation	(1-5)	_____
4.	Safety and compliance to health codes	(1-5)	_____
5.	Frequency of cleaning and maintenance	(1-3)	_____
6.	Amount of cleaning and maintenence	(1-3)	_____
7.	Ease of cleaning and maintenance	(1-5)	_____
8.	Durability and reliability	(1-3)	_____
9.	Energy efficiency	(1-10)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

FRYER EVALUATION FORM GUIDE

1. Capacity is not ranked. If proper capacity is not selected, none of the other criteria will be applicable.

2. For consistent quality in deep fat frying, temperature must be accurately maintained at the selected level. This requires accurate thermostats and sufficient heat input and oil capacity to support frying load. If frying debris is a factor, a cold zone should be selected.

3. Operation of fryer requires frequent lifting of baskets in and out of well. The fryer must be at the proper height for this operation. Basket handles should be easy to grasp, and controls visible and easy to turn.

4. Use of hot oil can be dangerous. Fryer must be suited for its intended use. Splashing of oil out of reservoir should be minimal. Controls should stay cool enough to touch. A safety thermostat must be present to protect against failure of main unit.

5. Thermostats should be calibrated frequently, and gas jets checked periodically. These factors will vary among manufacturers. Compare and rank.

6. Amount of maintenance other than normal cleaning is limited. Compare steps in procedure for calibrating unit and amount of attention gas jets require.

7. Cleaning must be done frequently according to the needs of the individual establishment. Look for one-piece construction of panels, minimal projections on heating elements, tight joints, and an easily cleanable surface.

8. Fryers are evolving rapidly. Durability concerns are not that great, as replacement will probably occur from technological advancements. While desirable, reliability is not critical either. Fryers typically are very reliable, and most operations operate with multiple units.

9. Fryers are becoming more efficient, as manufacturers now are considering energy utilization a top priority. Compare heat inputs and relate them to product produced per time unit.

10. Warranty indicates manufacturer's commitment to his product. Compare, and rank the most complete warranty highest.

11. Service, in reality, is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently, small service businesses who must use answering services or machines are difficult to reach, and they may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR COFFEE URNS

Coffee urns are an efficient method of producing large amounts of coffee. The coffee urn must provide a method of heating water to brew coffee, a method of maintaining temperature of finished brew, a storage receptacle for proper storage of brewed coffee, a method for dispensing beverage, a system for leaching coffee from grounds, and a system for flowing water over the leach bed.

External surfaces of most urns are usually 18-gauge stainless steel. Interior brew containers may be constructed of stainless steel or teflon-coated steel. Some metals, such as copper, chromium, tinplate, and aluminum, will impart a metallic taste to coffee and should be avoided for use in the finished brew containers. Water reservoirs holding hot water prior to brewing may be of any noncorrosive metal. Urn size will range from 3 to 20 gallons.

Heating of water may be either gas or electric. Electric power is more common. The water-holding chamber will be heated with between 5- and 15-kW immersion heating elements. Larger heat inputs will provide faster recovery time and faster coffee production. Gas heat will be provided by flames striking the chamber bottom. Steam coils may also be used to heat the water.

Water temperature in the holding chamber should be around 200 degrees F. When brewing of a batch is desired, water is poured, pumped, or siphoned from the holding chamber to the leach bed. Automatic urns use an automatically regulated cycle time to pump the correct amount of water over the coffee grounds. Flow rate must be sufficient to keep the grounds immersed, but not fast enough to flood the basket.

The leach system may be one of several types. Leachers may be cloth urn bags, perforated metal plates, metal strainers, or paper filters. Cloth bags may be reused many times, but require rinsing between each batch. Cloth bags may be cotton or Dacron. Dacron lasts much longer than cotton. Paper filters are disposable, and cleaning and inconsistency problems due to clogging of the leacher are eliminated. Both cloth bags and paper strainers require leach baskets, which adequately support the filter but do not hinder the leaching of beverage. Metal strainers are fine wire mesh screens that hold the coffee grounds directly. The primary problem with this method of leaching is the clogging of the screen with fine coffee particles. Fines are very difficult to clean from the filters. Perforated plate leachers allow brew to leach through a set of fine holes in a flat plate. Under the first plate is a second plate with more holes, but the holes are offset from the top set of holes forcing the water to travel laterally between the two plates. This slows the leach rate to the proper speed. Again, the problem with this system is clogging of holes.

Coffee brew container must be maintained at 185 to 190 degrees F to allow dispensing of beverage at the proper temperature. Brew container may be separately heated from water reservoir, or reservoir may actually be a jacket surrounding the brew container providing heat in this manner. The latter is less expensive, but control of temperature is not as precise. Coffee should be agitated in this chamber, usually with air injected into the bottom of the chamber.

Faucets dispensing the beverage should have plastic handles to protect against heat. Faucet may be a dairy type valve or spring loaded plunger valves. Connected to the faucet system should be glass volume gauges indicating the amount of liquid in each reservoir.

Options available with coffee urns include: timers for automatic start of brewing, covers for tanks, bypass to permit addition of water to brewed coffee, low water cutoff to protect the urn if water level falls too low, faucets on front and back of urn, automatic refill of water reservoir, and thermostats for each holding tank.

Capacity. When calculating the capacity of the urn, it must be considered that the grind will absorb about one quart of water for each pound of grind used. While one reservoir is dispensing, the other may be brewing. This is important as the brewer may not be used until the reservoir into which the beverage will flow is empty of the last batch of brew. Calculate required capacity according to system outlined in the General Parameters section of this paper.

EVALUATION FORM FOR COFFEE URNS

Brand _____ Model _____

NSF Approval _____ UL Approval ____

AGA Approval ____ ASME Approval ____

Heat input: _____kW (Btu)

1.	Capacity: _____ gallons		
2.	Consistency and quality of product	(1-7)	_____
3.	Ease of operation	(1-5)	_____
4.	Safety and compliance to health codes	(1-5)	_____
5.	Frequency of cleaning and maintenance	(1-3)	_____
6.	Amount of cleaning and maintenance	(1-3)	_____
7.	Ease of cleaning and maintenance	(1-5)	_____
8.	Durability and reliability	(1-7)	_____
9.	Energy efficiency	(1-5)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

COFFEE URN EVALUATION FORM GUIDE

1. Capacity is not ranked. If proper capacity is not selected, none of the other criteria will be applicable.

2. Product consistency is very important. Variations will occur if water temperature is not accurately maintained, leach rate is altered, tank agitation is inadequate, or tank is not cleaned properly. Compare controls of each of these areas.

3. Coffee urns are used in production lines, and ability to operate them with little manual attention is desirable. Look for automatic urns that require only minimal cleaning between batches.

4. Hot water is used in coffee brewing, and units should be insulated and handles heat protected. Covers should lift in a manner that prevents operator from being scalded by steam.

5. Thorough cleaning and maintenance must be performed daily to provide consistent quality product. There should be little variation in required cleaning except in leachers. Paper leachers require no maintenance.

6. Amount of maintenance also varies little. The same tasks must be performed on all units.

7. The amount and difficulty of disassembly required to clean the urn must be compared.

8. This is important as the machine is usually plumbed in place and difficult to replace temporarily if broken. Adequate heat input for desired capacity will prevent most breakdowns.

9. Energy utilization can be improved if tanks are insulated against heat loss.

10. Warranty indicates manufacturer's commitment to his product. Compare, and rank the most complete warranty highest.

11. Service, in reality, is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently, small service businesses who must use answering services or machines are difficult to reach and they may have smaller parts inventories. The best indicator is past experience.

EVALUATION SYSTEM FOR GRIDDLES

Griddling is cooking by heat conduction from a heated plate directly to the food product. As this occurs, the plate cools and must be reheated. Thus, the temperature at any given point on a griddle will vary constantly. Production capacity increases directly with the rate of recovery of a cool spot on a griddle. The thinner the griddle, the faster the recovery time. The thicker the surface, the more even the surface temperature will be. Griddle thickness may range from 1/2 inch to 1-1/2 inches. This is a tradeoff, and individual operations will vary in their requirements. Institutional feeding establishments may be better served with a thin, high-recovery griddle, while an up-scale restaurant may desire more consistent temperatures.

Griddles typically are divided into zones one foot wide. Each zone has an independent thermostat and heat source. Thermostats usually are fluid-filled rods in the middle of each zone clamped tightly to the underside of the heating surface. Expansion of the liquid inside the rod activates a switch turning off the heat source. During subsequent cooling, the liquid contracts, turning on the heat source. The thermostat is capable of measuring only the temperature of the portion of the griddle with which it is in direct contact. Consequently, a griddle in use may have temperature variations of 100 degrees F or more from one spot to another. Because of the cyclical nature of a thermostat control system, a griddle at rest may at any given time, be 50 degrees hotter or cooler than the temperature at which it is set.

Griddles lose heat when at rest. A griddle set at 350 degrees typically will lose about 200 watts per square foot of griddle space. A dirty griddle will radiate more heat than a clean one. The shinier the surface, the less heat will be lost.

Newer models of griddles feature platinum temperature detectors, which greatly reduce the temperature swing around the desired temperature. Others are using more lights and Liquid Electronic Displays (LEDs) to signal the temperature and stage of the heat source.

Surface of the griddle may be flat, grooved, or a combination of the two. The grooved surface allows the branding of meats, but it limits the capabilities of the machine, as eggs, pancakes, etc. cannot be cooked on a grooved surface. A grooved surface will be tilted towards the grease trough for easier removal of grease. Flat surfaces must be extremely level to permit the cooking of liquids.

Griddles may be either gas or electrically powered. Elements clamped to the underside of the griddle plate transfer heat to the plate in electric units. The longer the elements, the more even heating of the surface. Gas griddles have gas lines with ports under the griddle surface. Again, the more gas ports, the more even heating.

A new development in griddles is the fluid griddle. This is a relatively thin top (12-gauge stainless steel) over a partially fluid filled vacuum chamber. Heat is applied to the fluid which turns to steam at some temperature around 350 degrees F. This steam condenses on the underside of the top plate. When a condensate droplet becomes large enough, it drops off

the underside of the top plate making room for more steam to condense. When a cold food object is placed on the top surface of the griddle, it absorbs heat rapidly from the thin plate. This speeds the condensation process under the plate allowing more heat energy to be applied only to the area requiring it quickly. (For a more complete description of steam properties, see Fundamentals of Steam attached to Appendix A of this report.) These griddles perform more efficiently and consistently than conventional griddles.

Capacity. Capacity requirements depends upon the physical requirements of the individual operation. It must be remembered that the slowest link in the production chain will be the capacity determining element. Thus, although the griddle may be capable of 1000 burgers per hour, if serving capacity is only 600 burgers per hour, the griddle capacity will be inefficiently utilized. Increasing the capacity of a griddle only gives the operator more work space. Calculation of needed capacity should be done according to the procedures outlined in the General Parameters section of this report.

EVALUATION FORM FOR GRIDDLES

Brand _____ Model _____

NSF Approval ____ UL Approval ____ AGA Approval ____

1.	Capacity: _____ burgers per hour _____ burgers per load		
2.	Consistency and quality of product	(1-10)	_____
3.	Ease of operation	(1-5)	_____
4.	Safety and compliance to health codes	(1-3)	_____
5.	Frequency of cleaning and maintenance	(1-3)	_____
6.	Amount of cleaning and maintenance	(1-3)	_____
7.	Ease of cleaning and maintenance	(1-5)	_____
8.	Durability and reliability	(1-3)	_____
9.	Energy efficiency	(1-10)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

GRIDDLE EVALUATION FORM GUIDE

1. Capacity of machine is from manufacturer's projected peak performance levels. This should be greater than the expected peak capacity required in the specific location. This portion is not ranked, as the successful evaluation of the machine is dependent upon the accuracy of this calculation.

2. Consistency and quality of product paramenters will vary according to what is expected of the griddle. This is an important consideration. If fast recovery is imperative, it should be one of the considerations. If even temperature is important, a thicker, more advanced machine should be considered. Rank according to requirements.

3. The griddle should be at a comfortable height. Grease run should be easy to reach and wide enough to be scraped clean. Controls should be easily readable and accessible. There should be storage space for utensils.

4. Griddle needs to be securely supported, especially if griddle is mobile. Wiring, or gas pilots should be well protected.

5. Griddle surface must be cleaned thoroughly daily. A major variable is the size of the grease cup. It should be large enough to last through the day's production.

6. All surfaces other than the griddle surface must be cleaned. The size and number of splash guards make an appreciable difference in cleaning. Inadequate grease cups can lead to increased cleaning.

7. Cleaning jobs should be able to be performed easily. Corners of splash guards should be rounded so they can be reached. The grease run must be wide enough to permit scraping.

8. Griddles typically are very reliable. Failures are primarily due to abuse of the griddle surface.

9. Energy efficiency is a comparison ranking between griddles evaluated. Rank the lowest energy user the highest.

10. Warranty indicates manufacturer's commitment to his product. Compare, and rank most complete warranty highest.

11. Service, in reality, is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently, small service businesses who must use answering machines or services are difficult to reach and may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR MEAT SAWS

Meat saws are a band type saw specifically designed for the sanitary sawing of meat products. The machine is also ideal for cutting frozen food blocks into consistent portions.

Meat saws usually are floor mounted on a heavy base with the saw table at the same height as adjacent work table. This allows heavy products to be manipulated on the saw more easily. Smaller saws are now being manufactured that are countertop mounted and may be moved when not in use.

Saw blade is a continuous loop about 110 inches in length. Blade width is between 1/2 and 3/4 inches. Blade rides on cast iron pulleys, one in the head of the saw and the other near the floor in the saw cabinet. Blade tension is adjusted by moving one of the pulleys up or down with a hand wheel. Most saws use a belt drive to turn the blade. Motor size will range from 1/3 HP to 3 HP depending on the size and intended use of the saw.

Saw table should be large enough to stack cut product while using the machine. Table is constructed of stainless steel and must be sturdy enough to support large cuts of meat. Behind the blade is a gauge plate, which is adjusted to control thickness of cut. Product to be cut is placed on a carriage table, which is ball-bearing mounted to allow easy movement of item being cut across the blade path. A separate push plate is available to move the product on the carriage closer to the blade after each pass. This keeps the operator's hands away from the blade.

The head of the saw containing the top pulley must be located high enough above the table to permit cutting of thick products. On full-size saws, this is around 18 inches from the table. The saw throat must also be deep enough to handle large pieces of meat. This typically is between 12 and 15 inches.

Cleaning of the saw requires disassembly and removal of the blade. All components that must be removed or accessed should require no tools to remove them.

Capacity. Capacity of a meat saw is more a size function than a time function. Saw must be selected so it is large enough to accept all products to be cut. Selection of a saw too large will result in unnecessary capital expenditure, higher energy usage, and waste of valuable kitchen space.

EVALUATION FORM FOR MEAT SAWS

Brand _____ Model _____

NSF Approval _____ UL Approval _____

1.	Capacity: _____ in. throat depth _____ in. depth of cut		
2.	Consistency and quality of product	(1-5)	_____
3.	Ease of operation	(1-5)	_____
4.	Safety and compliance to health codes	(1-7)	_____
5.	Frequency of cleaning and maintenance	(1-5)	_____
6.	Amount of cleaning and maintenance	(1-5)	_____
7.	Ease of cleaning and maintenance	(1-7)	_____
8.	Durability and reliability	(1-3)	_____
9.	Energy efficiency	(1-3)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

MEAT SAW EVALUATION FORM GUIDE

1. Capacity is not ranked. If proper capacity is not selected, none of the other criteria will be applicable.

2. Consistency is machine affected by the accuracy of gauge plate, trueness of travel of the carriage, and sharpness of blade. Gauge plate should lock firmly in place; there should be no wobble in carriage, and blade quality should be high.

3. Saw should handle heavy weights easily. Carriage should be bearing mounted with table at convenient height. Controls should be easy to reach.

4. Saws have exposed blades. Push bar and carriage should allow complete operation without hands being near the blade. Blade removal shou'd be simple.

5. Saws must be thoroughly cleaned after each use. Motor, pulleys, and carriage must be lubricated. Compare manufacturers' specifications for recommended frequencies.

6. Amount of maintenance will vary as some manufacturers are using sealed bearings. Compare manufacturers' specifications.

7. As the machine must be disassembled for cleaning, this aspect is important. No tools should be required to access all parts of the machine that must be cleaned or maintained.

8. The saw must be heavy enough for its intended use. Purchasing proper size saw will ensure adequate durability and reliability.

9. Meat saws use relatively small amounts of current, and it is directly transmitted to the blade. Thus, differences in energy utilization are primarily differences in motor size.

10. Warranty indicates manufacturer's commitment to his product. Compare, and rank the most complete warranty highest.

11. Service, in reality, is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently, small service businesses who must use answering machines or services are difficult to reach and they may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR VERTICAL FOOD MIXERS

Mixers integrate two or more food ingredients to make a homogeneous mixture. The ingredients may be solid or liquid, or a combination of liquids and solids. A large variety of attachments permits the machine to be extremely versatile.

Vertical mixers have overhead motors and a range of speeds that allows them to perform many tasks. Vertical mixers may be purchased in sizes from 5 quarts to 140 quarts. Most common sizes currently manufactured are 5, 20, 30, 40, 60 and 80-quart machines. Models up to 20 quarts may be countertop mounted, while larger units are either floor or wall mounted. Wall mounting allows easy cleaning under the unit, but walls must be reinforced to support the unit. Some wall units are available that fold out of the way.

Basic parts of the vertical mixer are the head, bowl support yoke, frame and base, bowl, and attachments.

The head of the mixer contains the motor, gearing system, and all electrical switching in the machine. The motor will range in horsepower from 1/6 to 5 HP. Gear system slows the motor RPM to usable speeds, provides shock absorbing capability to absorb the force exerted when the machine starts under heavy loads, and develops the "double rotation" movement of the attachment in use. The entire blade will spin in one direction, while the gear system will move the rotating blade around the bowl in the opposite direction the blade is spinning. This allows the product to be pulled away from the sides of the bowl and thoroughly mixed. When the blades are immersed in heavy solids, the force of the motor suddenly starting could damage the unit. This is compensated for in two ways. First, the nature of the electrical motor provides some shock relief. When current is first applied to the motor, the motor uses this

current to start turning. Because of inertia, it takes far more current to start the motor turning than to maintain the rotation. As the current is reaching the level high enough to overcome the resistance of the bowl contents, energy is given off from the motor in the form of heat. As the electrical current level approaches the point high enough to start the blade spinning, less electrical current is given off as heat, and more is converted to the useful form of energy of turning the motor. This transition in energy form, which occurs in 1/2 second or less, provides some of the necessary shock relief. Manufacturers also build in some additional shock relief by using springs, gears, and/or belts.

Speed of the attachment ranges from around 50 RPM to 330 RPM. Varying the gear combination and switching combinations of current to the motor make this possible. Also attached to most gear boxes is a power takeoff, which can operate accessories other than inside the bowl. Power takeoff speeds typically are about double the bowl RPMs.

Mounted on the control head are the operating controls. There will be an on/off switch, a speed selector switch, and, as an option, a timer.

The bowl support yoke is a "C" shaped assembly, which holds the bowl in place. Most have two pins at each end of the "C" which fit into holes in the bowl. The rear of the bowl is also retained; either in a slot, a hole and pin arrangement, or some type of clamp. The bowl is thus securely held, unable to rotate or tip. The support yoke is attached to the main frame in a slide assembly. This allows the yoke to be raised and lowered, moving the bowl and its contents in and out of the path of the blade. Movement of the yoke may be with a hand lever in small mixers and a gear reducing arrangement in large mixers, which may be operated with a hand crank or electric motor.

The base of the mixer must be heavy enough to counter the weight of the

control head. Bases are usually cast and very close to the floor. This makes cleaning under them difficult, as the machines are difficult to move, and too close to the floor to easily clean under them. The support shaft is also usually cast, and it contains the slide mechanism for the bowl support yoke to move in. Power wires usually run from the control head to the base of the machine through the support shaft.

Bowls may be purchased either of stainless steel or tinned. Stainless bowls have the advantage of durability. Tinned bowls must periodically be retinned, and they may darken the color of some products. Larger mixers have adapters that allow smaller bowls to be used. Smaller attachments must also be purchased. Large bowls, typically because of their great weight when loaded, will be lowered onto a wheeled floor dolly for moving about the kitchen.

Attachments may be constructed of cast aluminum, stainless steel, or tinned or chromed steel. There is a wide variety of attachments available. Some of them are: flat beater, dough hook, wire whip, wing whip, pastry knife, and sweet dough hook.

Some power takeoff attachments available are: vegetable slicer, vegetable shredder, coffee mill, juice extractor, tool sharpener, food chopper, and dicer.

Other options that may be considered when purchasing a mixer are: hot/cold water jacket, splash protectors, oil dropper, and a colander sieve.

Capacity. Special considerations in calculating capacity of mixers are adequate head space to prevent excess splashing and enough room to allow for product expansion. These levels will vary depending on the products used in the mixer. An extreme example of this is whipping cream, where 80% head space must be provided. When factoring in headspace requirements, capacity should be calculated according to the procedure outlined in the General Parameters section of this report.

EVALUATION FORM FOR MIXERS

Brand _____ Model _____

NSF Approval _____ UL Approval _____

Operating voltage _____ Horsepower _____

1.	Capacity: _____ quarts		
2.	Consistency and quality of product	(1-3)	_____
3.	Ease of operation	(1-5)	_____
4.	Safety and compliance to health codes	(1-5)	_____
5.	Frequency of cleaning and maintenance	(1-5)	_____
6.	Amount of cleaning and maintenance	(1-3)	_____
7.	Ease of cleaning and maintenance	(1-5)	_____
8.	Durability and reliability	(1-10)	_____
9.	Energy efficiency	(1-3)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

VERTICAL MIXER EVALUATION FORM GUIDE

1. Capacity is not ranked. If proper capacity is not selected, none of the other criteria will be applicable.

2. Mixer will perform according to operator inputs. There are few machine functions that will affect consistency and quality. Selection of proper attachments is critical.

3. Much product manipulation is required to operate mixer. Bowl lowering/raising should have enough mechanical advantage for easy operation. Bowl should be easy to reach. Attachments should be easily changeable.

4. Safety is important as the machine has an exposed turning beater. On/off switch should be easily accessible. All surfaces should be smooth and rounded.

5. Frequency of cleaning depends upon use rate. Lubrication of bowl support slide may vary in recommended frequency of maintenance.

6. Amount of cleaning and maintenance will vary little. Select a machine that has sealed motor, gears, and bearings.

7. Cleaning should be easily accomplished. External surface should be smooth, and there should be few crevices to trap food particles.

8. Durability is dependent upon the intended use of the machine. Machines used extensively for heavy doughs will place a greater stress on motor and gear assemblies. Select a heavy shock absorbing system, and motor size 1/2 horsepower greater than normal for these types of operation.

9. Mixer power is transmitted directly from motor to blades. Energy usage is directly determined by motor size. Select proper size unit for intended use.

10. Warranty indicates manufacturer commitment to their product. Compare, and rank the most complete warranty highest.

11. Service, in reality, is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently, small service businesses who must use answering machines or services are difficult to reach, and they may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR PRESSURE COOKERS

Pressure cookers use steam to cook food that is not immersed in liquid. As the steam is coming in direct contact with the food product, clean steam is required. Pressure cookers work at different pressures ranging from 5 to 15 psi. The pressure of the chamber affects the temperature at which the unit operates and the rate of cooking. Steam cooking is precise, as there is no variation in temperature at a given pressure. Cooking is fast, and energy utilization is extremely efficient. Space utilization is also improved as the units are not as large as other machines capable of performing similar functions. Steamers are unable to brown foods, nor can they impart a charred flavor. Nutrient retention is much greater than with most other cooking methods.

Steam cooking is accomplished by transfer of heat from steam, and heat of fusion given up by the steam as it condenses on the food product. (See Fundamentals of Steam).

Steam may be provided to the unit by an external steam generator or by a boiler built into the unit itself. Boilers may be electric or gas fueled. Electric immersion boilers are more efficient, approaching 100 percent efficiency. Gas boilers will range from 50 to 65 percent efficiency depending upon their design. If external steam is used, it must be clean steam. If steam source is not clean, a heat exchanger is required to transfer heat from the building steam to the clean steam of the machine.

Selection of a steamer type is based primarily on capacity requirements. Large operations require units that will accept full hotel pans. Up to 8-inch-deep pans may be used, but these have great potential for uneven heating. Smaller operations may better utilize steamers with round or oblong openings as these units are smaller, use less space, and use smaller pans.

Construction of the unit should be primarily of stainless steel for external and internal surfaces. Doors are also stainless, with a heavy rubber gasket to seal the unit. Doors are fastened with a hand wheel/screw system, or a lever which locks the door against the internal pressure of the unit. Doors may not be opened, if there is any positive pressure in the cooking compartment.

Controls should include an on/off power switch with pilot lights, thermostat controls, pressure gauge, thermometer, and a 15- and 60-minute timer. Accurate and complete controls are necessary as the product may not be viewed while it is cooking.

Steam should be introduced to the chamber via jets located evenly throughout the interior of the chamber. This method will cook faster and more evenly than introducing steam only at the bottom of the chamber.

Capacity. Capacity calculations should consider time required to handle pans and the size of pans used. Calculate required capacity according to system outlined in the General Parameters section of this report.

EVALUATION FORM FOR PRESSURE COOKERS

Brand _____ Model _____

NSF Approval ____ UL Approval ____

AGA Approval ____ ASME Approval ____

Operating pressure _____ psi.

1. Capacity: _____ pans per hour of _____ product at _____ lb per pan.

2.	Consistency and quality of product	(1-5)	_____
3.	Ease of operation	(1-7)	_____
4.	Safety and compliance to health codes	(1-5)	_____
5.	Frequency of cleaning and maintenance	(1-3)	_____
6.	Amount of cleaning and maintenance	(1-3)	_____
7.	Ease of cleaning and maintenance	(1-5)	_____
8.	Durability and reliability	(1-5)	_____
9.	Energy efficiency	(1-5)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

PRESSURE COOKER EVALUATION FORM GUIDE

1. Capacity is not ranked. If proper capacity is not selected, none of the other criteria will be applicable.

2. Product consistency will be affected if cooker is loaded beyond its normal capacity. Controls must be extremely accurate for proper operation.

3. Ease of operation is affected by handle type. Machine should open and close easily, and door should remain out of the way when loading/unloading is taking place. Some units are stacked so the top chamber is above a feasible working height. Avoid this.

4. Steam can cause serious burns. Door gaskets must be durable. Door must have positive lock to prevent opening while unit is under pressure.

5. Frequency of cleaning and maintenance is determined by use rates. All machines must be cleaned daily. Intervals for lubrication of door hinges and latch and calibration of thermometer and pressure gauge may vary.

6. Variabilities in amounts of maintenance will occur depending on door lock system and pressure sensing system. Compare manufacturer's specifications in these areas.

7. Complexity of calibration method may vary here. Ease of cleaning will be affected by finish and structure of surfaces. Look for smooth surfaces with rounded corners and few joints. Gasket/door frame junction may vary considerably in cleanability.

8. Durability will be based upon quality of steam source, and a large enough machine. Select a large enough steam source. Door gasket should be heavy in construction.

9. Energy consumption will vary in method of steam generation. Compare efficiency ratings for different boilers. Insulative qualities of the chamber are also important. Match capacity of unit to cooking requirements.

10. Warranty indicates manufacturer's commitment to his product. Compare, and rank the most complete warranty highest.

11. Service in reality is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently, small service businesses who must use answering machines or services are difficult to reach, and they may have a smaller parts inventory. The best indicator is past experience.

EVALUATION SYSTEM FOR STEAM JACKETED KETTLES

Steam jacketed kettles are a "sealed pot within a pot" construction. The inner jacket is the actual kettle, while the outer pot, the jacket, forms a steam chamber 2 inches thick between the kettle wall and the jacket surface. The jacket typically will extend either 2/3 of the way up the outside of the kettle, or over the full depth of the kettle. (Some very small kettles may use 1/2 jacketing.) Cooking is accomplished by the transfer of heat energy from steam in the steam chamber to the inner wall of the kettle, and from the kettle wall to the food product. (See Fundamentals of Steam for a complete description of steam heating.)

Steam kettles range in size from 1 quart to 200 gallon capacity. Construction is of stainless steel for virtually all kettles currently produced. Product removal is accomplished either through a tangent draw-off at the bottom of the kettle, or by tilting the entire kettle. If the kettle tilts, it may be hand tilted by a lever in small units, hand tilted by a gear arrangement in larger kettles, or electrically tilted in the largest kettles. Kettles may be counter-top models, floor models, or wall-mounted versions. Floor models may rest on legs or a single pedestal. Large kettles may have mixer paddles in them. Kettles are available covered or uncovered. Wire basket arrangements may be added which permit steaming of vegetables. Some models may be purchased with food pumps, which allow rapid portioning of homogeneous foods. Pan racks may be used to position hotel pans under the tangent draw-off. Larger kettles, i.e., over 50 gallons, should have power mixing capability as well as a water supply at the kettle location. Floor drains are also essential to allow for efficient draining of cleaning water.

There is a fundamental difference in shape between a 2/3 jacketed kettle and a fully jacketed kettle. Fully jacketed kettles will be more shallow, and a greater diameter than 2/3 jacketed kettles of the same diameter. The smaller diameter 2/3 jacketed kettles thus take up less floor space than fully jacketed models. The rim of the kettle will also be higher. This increases the difficulty of high maintenance cooking procedures as the operator must reach up into the kettle. A fully jacketed kettle will be at a more comfortable working height, and at capacity, the food product will not be as deep. This means that less weight will be placed on the product at the bottom of the kettle resulting in less crushing of fragile foods. The majority of kettles currently being marketed are 2/3 jacketed.

Steam may be supplied to the kettle from a building source of steam, a steam generator within the kitchen, or steam produced in the kettle itself using gas or electric energy. If the steam is generated by the kettle, the chamber will be hermetically sealed, and the small amount of water within the chamber will be continuously reheated. If an external generator is used, there will be a condensate drain of some sort attached. A self-contained generator makes more efficient use of steam generated than an external type, but the small size of the unit results in some loss of efficiency in steam production, and purchase price will be higher reflecting the cost of the independent steam generator. If building steam is used, no heat exchange system is required to provide clean steam to the unit because the steam never comes in direct contact with the food product.

Steam also transfers heat to the outer jacket of the kettle. This results in considerable energy loss. Steam kettles are available which have insulated jackets. These are very efficient, but they also greatly add to the purchase price of the kettle. They may be desirable, especially in small kitchens which tend to get very hot quickly.

Capacity. Capacity required is dependent upon the individual location's requirements. Procedures for determining the correct capacity are outlined in the General Parameters section of this project. When matching required capacity of a specific location to rated capacity of steam kettles one must leave adequate head space. Head space is the room left at the top of the kettle when filled to allow for stirring without sloshing over the edges. Amount required for this is between 15 and 25 percent of rated capacity.

EVALUATION FORM FOR STEAM JACKETED KETTLES

Brand _____ Model _____

NSF Approval _____ UL Approval _____

AGA Approval _____ ASME Approval _____

Self-contained steam generator _____ Electric _____ Gas _____

Tangent draw-off _____ Floor mounted _____ Wall mounted _____

Counter-top _____ Cover _____ Power mixing _____

1.	Capacity: _____ gallons		
2.	Consistency and quality of product	(1-3)	_____
3.	Ease of operation	(1-10)	_____
	Adequate accessories	(1-10)	_____
4.	Safety and compliance to health codes	(1-10)	_____
5.	Frequency of cleaning and maintenance	(1-3)	_____
6.	Amount of cleaning and maintenance	(1-3)	_____
7.	Ease of cleaning and maintenance	(1-3)	_____
8.	Durability and reliability	(1-10)	_____
9.	Energy efficiency	(1-3)	_____
10.	Warranty	(1-5)	_____
11.	Service	(1-5)	_____
	Total Rank Points		_____

Cost of Machine $_____

STEAM JACKETED KETTLE EVALUATION FORM GUIDE

1. Capacity is not ranked. Selected capacity should be greater than expected peak required capacity. Head space should be calculated for. Accuracy of this calculation is essential as the ultimate performance of the machine is dependent upon selection of the proper size machine.

2. Consistency and quality of product cannot vary significantly between steam jacketed kettles. Product is at the same temperature for all kettles operating at the same pressure. Rank according to expected product use versus methods kettle uses for product manipulation. (i.e., Will the mixing mechanism smash boiled potatoes? etc.)

3. Some products prepared in steam jacketed kettles require significant manipulation. The kettle should allow easy access for inspection, manipulation, and product removal. Covers should be counter-balanced, or constructed to provide easy opening. The amount of product typically prepared per batch in larger kettles cannot be handled without mechanical assistance. These assists, such as tilting mechanisms, need to be properly geared for easy operation. Many of the obstacles to easy operation may be overcome by selecting proper accessories. Addition of these can significantly alter the ease of a machine's operation. Compare available accessories between machines examined.

4. Safety is extremely important with this machine. Injury can occur from steam scalding, as well as strain due to the large volumes encountered. Steam protection can be enhanced by features such as handles offset on covers so the operator's hand is out of the way. Counter-balancing and positive locks to prevent tipping should be compared.

5. Cleaning must be completed after each use. Maintenance is primarily lubrication of moving parts. Calls for lubrication should be at moderate intervals. Compare between manufacturers.

6. This is primarily a comparison of the number of points requiring maintenance. Compare between manufacturers.

7. Ease of cleaning and maintenance refers to the accessibility of each part requiring attention. Lubrication and thorough cleaning should be possible with minimal disassembly. The tangent draw-off is extremely important as it must be removed after each use.

8. Compare gauge of metals. Control simplicity is also a factor. Machined parts should be of good quality and gear tooth depth sufficient. Self-contained steam generators should have a great enough capacity so the generator is not required to operate at maximum capacity. Threads on parts which must be frequently removed should be heavy enough to minimize the possibility of cross-threading and thread wear.

9. Energy efficiency is of minimal importance. There is so much difference between insulated and uninsulated kettles that the two types cannot be directly compared. It requires a constant amount of energy to produce a pound of steam, so the only effective comparison of energy efficiency is to rank differences in efficiency of self-contained steam generators. These differences will be small.

10. Warranty indicates manufacturer commitment to his product. Compare and rank the most complete warranty highest.

11. Service, in reality, is an evaluation of the agency. How fast do they respond to calls? Do they maintain parts in stock? Frequently small businesses who must use answering machines or services are difficult to reach, and may have a smaller parts inventory. The best indicator is past experience.

FUNDAMENTALS OF STEAM

Steam is water which is partially in its liquid state and partially in its gaseous state. When water is heated to its boiling point, the individual water molecules gain heat energy. As they gain energy, the molecules move faster and range greater distances from neighboring molecules. Eventually some molecules gain enough energy (around six times that required to bring water to its boiling point) to break the bonds between the water molecules which hold water in its liquid form. These individual molecules are the gaseous form of steam. They will disperse evenly throughout an enclosed steam chamber. When these gaseous molecules contact the wall of the steam chamber, or any other surface containing less heat energy than themselves, they transfer some of their heat energy to these surfaces, increasing the temperature of these surfaces. Gases tend to disperse evenly within a closed chamber, so the energy is evenly distributed to all portions of the steam chamber. Thus all portions of the steam chamber will be at the same temperature.

Temperature is automatically regulated by the properties of steam. Water being converted to steam will always remain at its boiling point in temperature. When the water gains enough energy to break free from the water surface, it is in a true gaseous state, often referred to as dry steam. As a gas, its temperature could increase indefinitely as long as heat was applied. In a steam-generation system, however, heat is applied only to the liquid water. Thus, as soon as steam breaks free from the surface of the water, it has no way of gaining any more heat energy, and it begins giving up energy to its surroundings. This is a reversal of the boiling process called

condensation. As heat energy is given up to the surroundings, the individual water molecules slow down. Eventually the normal binding forces between water molecules become strong enough to hold the molecules in a liquid form. As a condensate dropl gains water molecules, it gains heat energy. It reqires six times the energy of boiling water for a molecule to break free from liquid water. Thus, it will return to liquid form when its heat energy drops below six times that of water at its boiling point. This excess heat energy is transferred to other molecules in the droplet. As long as there are water molecules in a gaseous state within the steam chamber, the condensate droplets will not be able to drop in temperature below the boiling point of the liquid because the droplet's heat energy level is continually being maintained by the addition of new water molecules containing something less than six times the energy of boiling water.

In a steam system, the only control of temperature is pressure. At sea level, water boils at 212 degrees F. At high altitudes, this temperature will drop to around 203 degrees F. This is because the atmospheric pressure is less, and less heat energy is required for the water molecule to break the surface tension of the water. Conversely, a closed system under fifty pounds pressure per square inch will boil at 298 degrees F because more heat energy is required for a water molecule to overcome the pressure exerted on the surface of the water.

APPENDIX B.

PROCEDURES TO CLEAN COFFEE URNS

Procedure I

"Clean liners. Rinse with hot water and drain. Pour 2 gals. boiling water into each urn. Add urn cleaner material according to instructions. Scrub inside of urn with an urn brush. Drain, rinse, and drain again. Clean gas gauges with a gauge brush and rinse. Replace nut and close faucet. Drain and refill water jackets twice. Clean urn covers and cups. Clean exterior. Clean liners by boiling cleaning solution and water. Turn off heat, scrub inside wall. Drain again. Clean faucet openings, taking faucet apart and scrubbing inside with urn solution. Rinse and replace. When clean, allow fresh water to run through faucet to other parts."

SOURCE: "Good Equipment Maintenance Saves Money," Institutions, V84, No. 7, April 1, 1979, p. 100.

Procedure II

"Pour a gallon or two of hot water into the liner and scrub it thoroughly, then rinse until clean and sweet. Even more important, be sure that the faucet is scrubbed thoroughly. The urn liner is only touched by a comparitively small amount of coffee beverage, but every drop of coffee that is drawn from the urn passes through the faucet line and faucet. It is imperative that this area be cleaned thoroughly.

"After cleaning is completed, put a gallon or two of fresh water in the urn and leave it there until the next use. This will help to keep the urn sweet and fresh. Be sure, however, that the coffee makers are trained to remove the water in the morning before commencing to brew.

"At night leave the urn cover slightly ajar to permit free circulation of air in the interior."

SOURCE: CBC Coffee Workshop Manual, CBC of Pan American Coffee Bureau, N.Y., 1970, p. 15.

APPENDIX C

A LIST OF FOODSERVICE EQUIPMENT

RECEIVING
- Hydraulic Lift Truck
- Platform Truck
- Hand Truck
- Barrel Cradle
- Ring Dolly
- Gravity Feed Roller Conveyer
- Scale

DRY STORAGE
- Shelving
- Can Rack
- Mobile Ingredient Bin
- China and Glassware Containers

REFRIGERATED STORAGE
- Walk-in Cooler and Freezer
- Blast Freezer
- Remote Refrigeration
- Fish Storage Refrigerator
- Reach-in Refrigerator and Freezer
- Work Top Unit
- Full Size Sandwich Unit
- Pizza Make-up Table
- Cold Pan Unit
- Display Cooler
- Ice Cream Cabinet
- Small Refrigerator
- Specialty Units

PREPARATION EQUIPMENT
- Burger Forming Machine
- Electric Meatball Machine
- Breading Machine
- Crepe Machine
- Breader/Sifter
- Doughnut Sugaring Machine
- Doughnut Glazer
- Blender
- Automatic Cookie Dropper
- Vertical Cutter Mixer
- Meat Chopper/Grinder
- Automatic Meat Marinator
- Buffalo Chopper
- Continuous Feed Food Cutter
- Dough Divider/Rounder
- French Fry Machine

PREPARATION EQUIPMENT (Cont.)

- Mixers
- Pasta Machine
- Peeler
- Pie Forming Machine
- Pie Dough Roller
- Pizza Crust Roller
- Meat Saw
- Slicer
- Tenderizer
- Shrimp Peeler/Deveiner
- Vegetable Drainer
- Vegetable Washer/Drier
- Baker's Table
- Work Table

COOKING EQUIPMENT

- Char Broiler
- Gas Broiler
- Electric Broiler
- Upright Broiler
- Quartz Broiler
- Rotisserie Style Broiler
- Fryer
- Fat Filter
- Doughnut Fryer
- Low Pressure Fryer
- Griddle
- Grill
- Convection Oven
- Conventional Oven
- Reel Oven
- Microwave Oven
- Pizza Oven
- Conveyor Tunnel Oven
- Smoke Style Roast Oven
- Bar-b-que Pressure Cooker
- Range
- Chinese Range
- Gyros Cone Roaster
- Steam Generator
- Pressure Cooker
- Steam Kettle
- Trunnion Tilting Kettle
- Basket Cooking System
- Tilting Skillet
- Cheese Melter
- High Heat Radiant Oven
- Semi-automatic Spaghetti Cooker
- Automated Heavy Duty Cooking Equipment
- Hot Dog Roller Grill
- Food Warmer

VENTILATION AND FIRE PROTECTION EQUIPMENT

- Hood
- Squirrel Cage Fan
- Ducting
- Hood Lighting
- Automatic Fire Extinguishing System
- Dry Chemical Extinguisher
- Proximity Ventilator
- Dual Air Hood
- Ventilator Hood
- Compensating Hood

HOLDING, TRANSPORTING AND SERVING

- Counter or Work Top Unit
- Under Counter Unit
- Oven Style Wall Holding Unit
- Drop-in Steam Table Unit
- Heat-and-Hold Unit
- Open Bain Marie
- Electric Bain Marie
- Heat Lamp
- Soda Fountain
- Bread Box
- Grill Stand
- Tray Truck
- Silver Bin System
- Sandwich Rack
- Fast Food Display Unit
- Sneeze Guard
- Ice Cream Elevator Dispenser
- Milk Elevator Dispenser
- Milk Cooler
- Tray Conveyor
- Tray Stacker
- Hot Food Truck
- Tray Delivery Truck
- Ice Maker
- Ice Crusher
- Ice Cube Dispenser
- Coffee Percolator
- Coffee Urn
- Coffee Grinder
- Conveyor Toaster
- Pop-up Toaster
- Proofing Truck
- Heated Holding Truck
- Refrigerated Holding Truck
- Slant Shelf Unit
- Pan Dolly
- Dish Elevating Dispenser
- Roll Warmer
- Fish Market Tank
- Condiment Dispenser
- Beverage Dispenser
- Hot Chocolate Dispenser

HOLDING, TRANSPORTING AND SERVING (Cont.)
- Hot Water Dispenser
- Potato Warmer
- Refrigerator Salad Crisper
- Milk Base Shake Machine
- Other Beverage Dispensers

WARE WASHING AND SANITATION
- Water Heater
- Booster Heater
- Immersion Basket
- Dish Machine
- Tray Stacker
- Steam Booster
- Garbage Disposal
- Detergent System
- Pot Washer
- Garbage Can Washer

MAINTENANCE EQUIPMENT
- Bottle Buster
- Can Crusher
- Bug Killer
- Electric Hand Dryer
- Floor Machines
- Mopping Equipment
- Laundry Dryer
- Waste Compactor
- Trash Container

MISCELLANEOUS EQUIPMENT
- Emergency Lights
- Bus Cart
- Cash Register
- Dumb Waiter
- Fluid Griddle
- Magnetic Induction Range
- Energy Management System
- Water Conditioning Equipment
- Fruit Press
- Vending Machines
- Closed Circuit T.V.